

National Aeronautics and
Space Administration



EXPLORE SOLAR SYSTEM & BEYOND

NASA Town Hall

AAS 236th Meeting | June 1, 2020

Paul Hertz

Director, Astrophysics Division

Science Mission Directorate

@PHertzNASA

Slides posted at <http://science.nasa.gov/astrophysics/documents>



Outline

- Celebrate Accomplishments
 - Mission Milestones
- Committed to Improving
 - Inspiring Future Leaders
 - Research and Analysis Initiatives
- Research Program Update
 - Research & Analysis, Technology, Fellowships
 - ROSES-2020 Updates, including COVID-19 impacts
- Missions Program Update
 - COVID-19 impact
 - Operating Missions
 - Webb, Roman, Explorers
- Planning for the Future
 - FY21 Budget Request
 - Project Artemis
 - Supporting Astro2020
 - Creating the Future

NASA Events at the



Monday, June 1

115 NASA Town Hall – 1:40 pm EDT; Annie Jump Cannon Meeting Room

Tuesday, June 2

201 Dual-Anonymous Peer Review for NASA Astrophysics Proposals – 11:00 am EDT Annie Jump Cannon Meeting Room

216 STScI Town Hall – 1:40 pm EDT; Annie Jump Cannon Meeting Room

Wednesday, June 3

315 NASA-NSF Exoplanet Observational Research (NN-EXPLORE) Program at the WIYN Observatory – 2:50 pm EDT; Maria Mitchell Room

Monday, June 1 – Wednesday, June 3

Visit the NASA Virtual Booth in the Exhibit Hall

Exhibit webinars 10 times daily at

11:00, 11:30, 12:00, 1:30, 2:00, 2:30, 3:00, 3:30, 4:00, 6:00 EDT



NASA Astrophysics Division

Division Director



Paul Hertz
Astrophysics Division
Director



Jeff Volosin
Astrophysics Division
Deputy Director



ASTROPHYSICS
NASA's Science Mission Directorate

Program Executives



E. Lucien Cox
SOFIA, GUSTO, XRISM



Shahid Habib
COR, ExEP, PCOS
ARIEL, Athena, Euclid,
LISA



Jeff Hayes
Astrophysics Operating
Missions



David Jarrett
Roman



Mark Sistilli
Explorers Program
IXPE, SPHEREx
Balloons

Cross Cutting



Eric Smith
Chief Scientist
Webb



Jeanne Davis
Assoc Dir for Flight
ASM Program Manager



Mario Perez
Chief Technologist
SAT, RTF



Lisa Wainio
Information Manager,
Public Affairs Liaison

Administrative Support



Kelly Johnson
Administrative Assistant



Mathew Riggs
Administrative Assistant



Jackie Mackall
Program Support
Specialist



Ingrid Farrell
Program Support
Specialist

Program Scientists



Dominic Benford
APRA Lead
Roman



Valerie Connaughton
APRA (High Energy)
XRISM



Dan Evans
PCOS Program
NICER
Dual Anon.PR



Michael Garcia
APRA (UV/Optical),
CubeSats/SmallSats
Hubble, Athena



Thomas Hams
APRA (CR, Fund. Phys.)
Rockets/Balloons
GUSTO, LISA



Hashima Hasan
Education/Comms
Citizen Science, Archives
Astro. Advisory Cmte.



Douglas Hudgins
ExEP Program
ADAP Lead
TESS, ARIEL



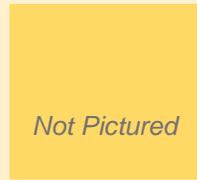
Stefan Immler
Astrophysics Research
Program Manager
Chandra, XMM



Patricia Knezek
Hubble Fellows
SOFIA



William Latter
APRA (Lab Astro)
Spitzer, SPHEREx, Fermi



Pamela Marcum
Exoplanet Research
Program (XRP)



Aki Roberge
ASMP, Roman



Rita Sambruna
GSFC
(on detail)



Evan Scannapieco
ATP / TCAN Lead
FINNIST, Swift



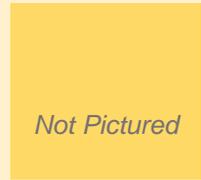
Kartik Sheth
COR Program



Linda Sparke
Astrophysics Explorers
Program



Eric Tollestrup
APRA (IR/Submm)
Euclid, IXPE



Future

Join the Team at NASA Headquarters

One or more program scientists will be hired this summer

Job opening starting June 15 (planned) for 5 days at <https://usajobs.gov>

Due to hiring authority used, applications will only be accepted during a 5-day window

AAS Job Register: <https://jobregister.aas.org/ad/8d061472>

Work as part of a diverse and agile team whose core values include excellence, integrity, transparency, teamwork and a growth mindset toward stewarding the nation's space-based astrophysics program

NASA encourages applications from candidates with non-traditional career paths, or individuals who are at earlier stages of their careers may have demonstrated experience in different ways.

Candidates are encouraged to contact NASA so they can make a well informed decision on submitting an application during the very short (5 day) window when the job opportunity will be open for applications

Questions about this anticipated opening for an Astrophysics Program Scientist at NASA Headquarters may be directed to Eric Smith, Chief Scientist, Astrophysics Division, eric.p.smith@nasa.gov



NASA Astrophysics Celebrate Accomplishments



NASA Science Plan Released

Science 2020-2024: A Vision for Scientific Excellence at <https://science.nasa.gov/about-us/science-strategy>

- Implement recommendations of Decadal Surveys in concert with national priorities and needs through creative partnership models that go beyond traditional ways of developing and executing missions
- Challenge assumptions about what is technically feasible and enable revolutionary scientific discovery through a deliberate focus on innovation, experimentation, and cross-disciplinary research
- Create a more collaborative culture within SMD and across science community, encouraging diversity of thought, sharing best practices, and informed risk-taking to improve operations
- Develop future leaders and inspire learners of all ages through new opportunities and hands-on experiences



Hubble Space Telescope at 30: Awesome
ies and Innovation", Jennifer Wiseman, Senior
Project Scientist (GSFC), AAS webinar: Monday
June 1 @ 2:00 pm EDT, Exhibit Hall

Next for Hubble?", Rachel Osten (STScI), AAS
Wednesday June 3 @ 2:00 pm EDT, Exhibit Hall



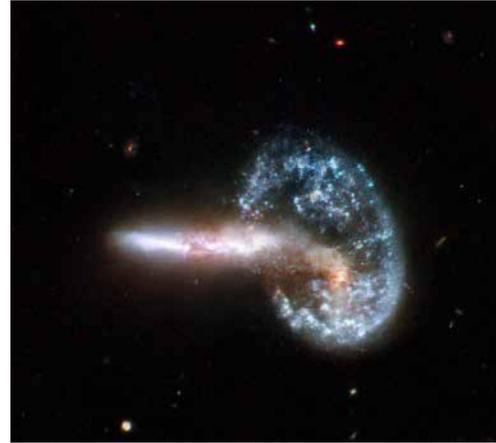
<https://www.nasa.gov/content/hubbles-30th-anniversary>



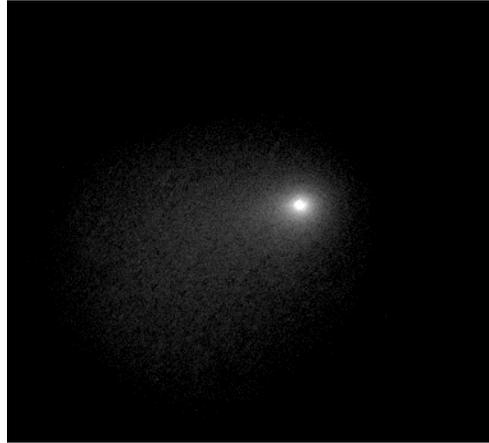
What did Hubble see on your birthday?



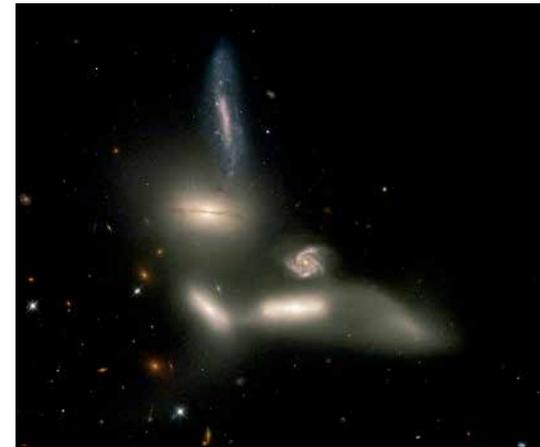
Galileo
Zwicky 18



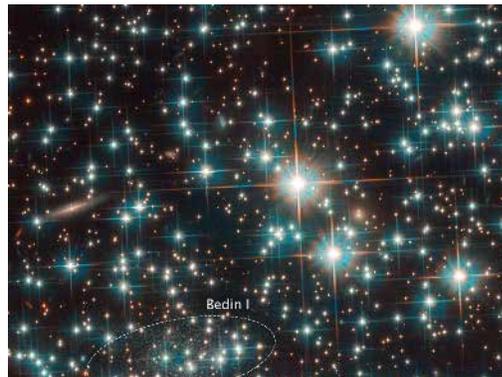
Edwin Hubble
Arp 148



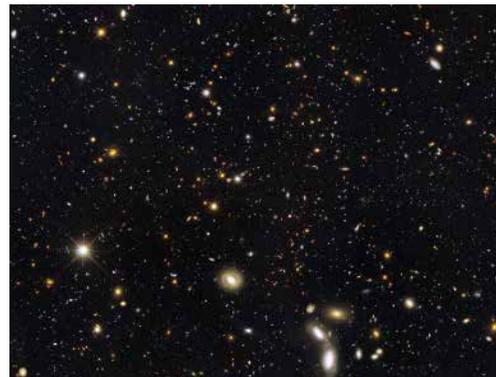
S. Chandrasekhar
Comet Siding Spring



Lyman Spitzer
Seyfert's Sextet



Arthur Compton
NGC 6752



James Webb
GOODS South



Nancy Grace Roman
Hickson Group 90



Vera Rubin
Jupiter

After 16.5 yrs of science exploration on the infrared cosmic frontier as one of NASA's Great Observatories, Spitzer ended its mission on Jan 30, 2020, 2:30 PST.



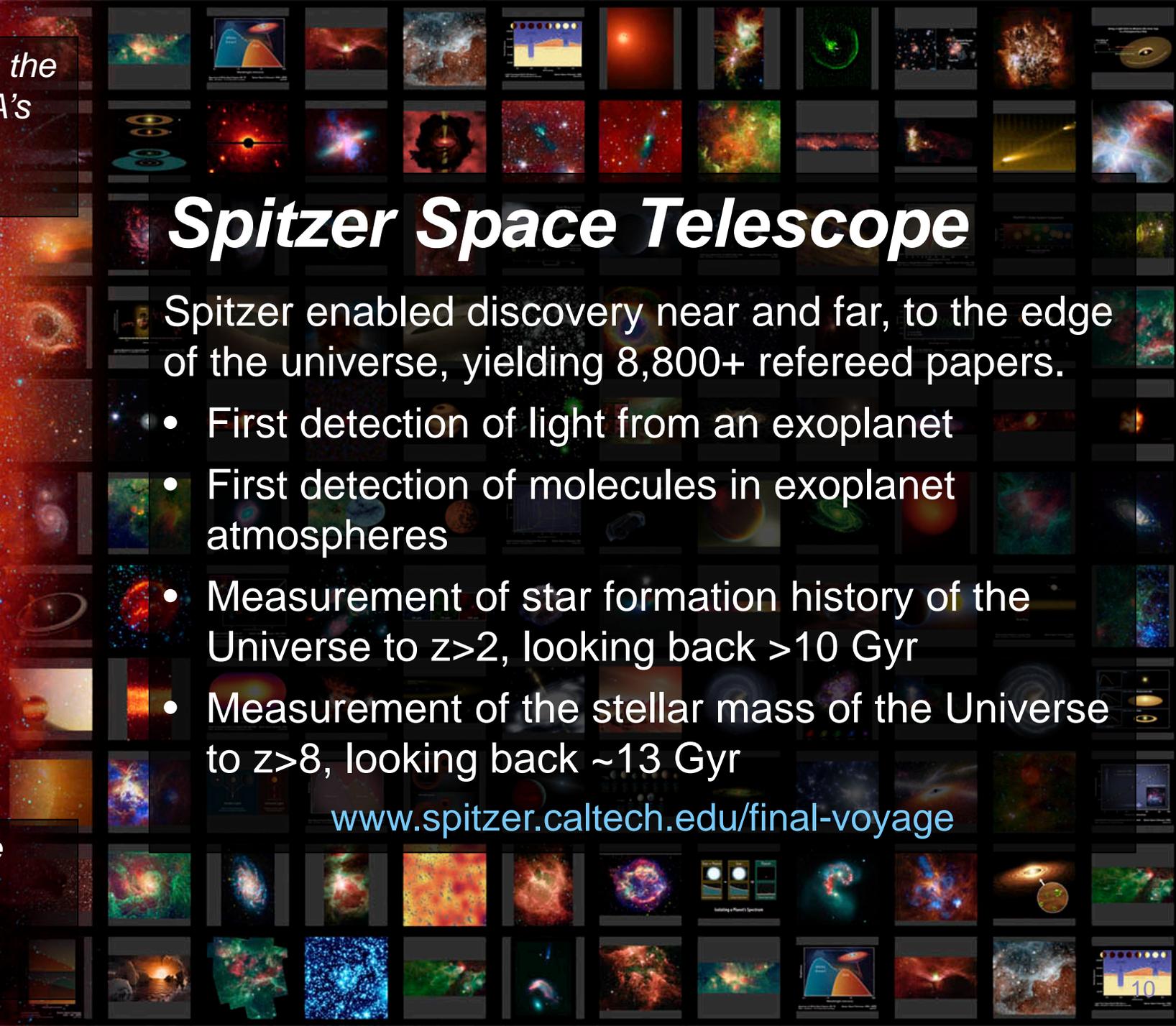
Engineering feats extended mission life post-cryo in 2009 and overcame challenges due to Spitzer's increasing distance from Earth.

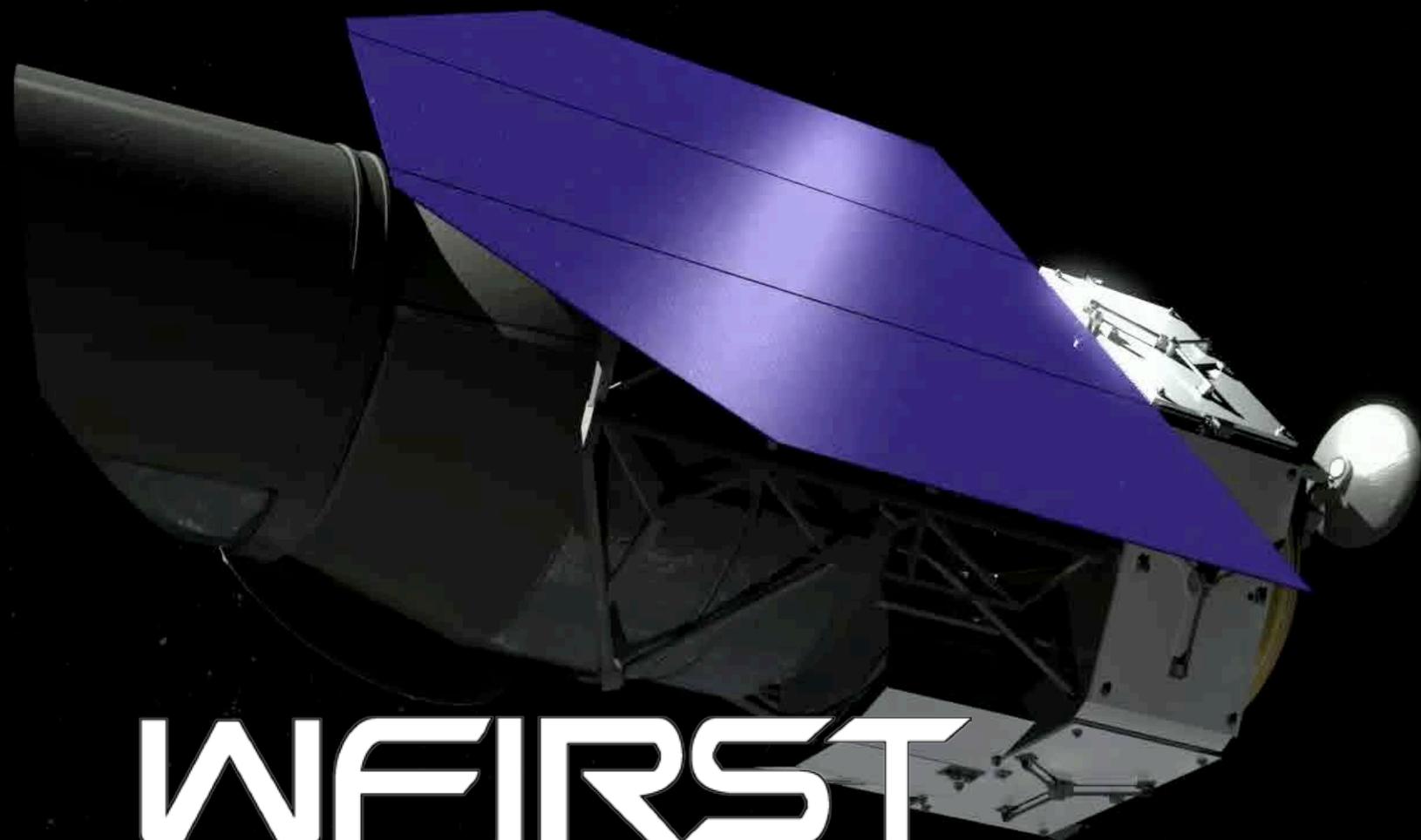
Spitzer Space Telescope

Spitzer enabled discovery near and far, to the edge of the universe, yielding 8,800+ refereed papers.

- First detection of light from an exoplanet
- First detection of molecules in exoplanet atmospheres
- Measurement of star formation history of the Universe to $z > 2$, looking back > 10 Gyr
- Measurement of the stellar mass of the Universe to $z > 8$, looking back ~ 13 Gyr

www.spitzer.caltech.edu/final-voyage





WFIRST



The
NANCY GRACE ROMAN
SPACE TELESCOPE

“Your Next Flagship: the Roman Space Telescope”, led by Dominic Benford, Roman Program Scientist, AAS webinar: Monday June 1 @ 3:30 pm EDT, Exhibit Hall

COVID-19: Bottom Line Up Front

Operating Missions & Data Archives: All performing nominally
Except SOFIA, which is currently not flying

R&A: NASA continues to solicit, review, select, and fund ROSES
and GO proposals through telework and virtual reviews

OMB has provided Agencies with flexibilities to better support proposers and
grantees, including soft money researchers and early career researchers

ADAP-21 is cancelled, ADAP-20 is doubled

XRP and TCAN proposal due dates are delayed

Missions in development: Each project is impacted differently

Project teams are doing as much as they can virtually right now

James Webb Space Telescope continues to be a priority

Work on NASA missions is being restarted safely at NASA Centers on a
case-by-case basis

Many of NASA's contractors and partners have continued to work



NASA Astrophysics Committed to Improving



PI RESOURCES WEBPAGE [1]

MISSION PI WORKSHOPS [2]

ASSURE DIVERSITY OF MISSION
PEER REVIEW PANELS

WEBINAR BY THOMAS ZURBUCHEN
ON WRITING SUCCESSFUL MISSION
PROPOSALS

CODE OF CONDUCT FOR SMD-
SPONSORED CONFERENCES

NEW AWARD TERMS AND CONDITIONS
FOR GRANTS

DUAL-ANONYMOUS PEER REVIEW

PROPOSAL WRITING WORKSHOPS AT
CONFERENCES

CODE OF CONDUCT & IMPLICIT BIAS
TRAINING FOR ROSES PANELS

ASTRO2020 STATE OF THE
PROFESSION



BUILDING AN
EXCELLENT
WORKFORCE

[1] <https://science.nasa.gov/researchers/new-pi-resources> [2] <https://science.nasa.gov/researchers/pi-launchpad>

Excellence through Diversity



Research shows that excellence of teams and diversity go hand-in-hand, especially in innovative activities

Excellent teams require diverse opinions and perspectives, and foster a sense of community by encouraging healthy behavior through actions

Team size should match the work required and the skills needed

Teams should be built with diversity in mind from the beginning, not as an afterthought

Change is hard. It happens incrementally, but it is important that we do what we can right now to tackle these issues

Inspiring Future Leaders



Achieve excellence by relying on diverse teams, both within and external to NASA, to most effectively perform SMD's work

Attract and retain talent by promoting a culture that actively encourages diversity and inclusion and removes barriers to participation

Encourage development of future leaders, including the next generation of mission principal investigators, through targeted outreach and hands-on opportunities

Support early-career scientists to build careers working with NASA

Engage the general public in NASA Science, including opportunities for citizen scientists

Mission PI Development

Seek to increase the diversity of mission principal investigators and develop the next generation of mission leaders to ensure that new ideas and mission concepts are brought forward

NASA Science has:

Developed a consolidated PI resources webpage at <https://science.nasa.gov/researchers/new-pi-resources>, which also includes SMD presentation on lessons learned from past selections

Introduced a pre-reviews of mission peer review panels to ensure diversity and reduce conflicts of interest

Included career development positions and associated evaluation criteria as part of AOs

Held first “PI Launchpad”

Hosted “So You Think You Want To Be A NASA Mission PI” town halls

First PI Launchpad



Aimed at researchers and engineers who would like to submit a NASA space mission proposal in the next few years but don't know where to start

<https://science.nasa.gov/researchers/pi-launchpad>

Nancy Grace Roman Technology Fellows

2019:

Regina Caputo, NASA GSFC (cosmic rays/gamma-ray)

Sarah Heine, MIT (optics and gratings for polarimeters)

Gregory Mace, UT Austin (optics and spectroscopy)

2018:

Manel Errando, Washington University, St. Louis

Adam McCaughan, NIST/Boulder

Varun Verma, NIST/Boulder

2017:

Abigail Vieregg, University of Chicago

Omid Noroozian, NRAO

2016:

Erika Hamden, California Institute of Technology

Daniel Cunnane, NASA Jet Propulsion Lab

Eric Schindhelm, Southwest Research Institute

2015:

John Conklin, University of Florida

Brian Fleming, University of Colorado

Tyler Groff, Princeton University

2014:

Not solicited

2013:

Cullen Blake, University of Pennsylvania

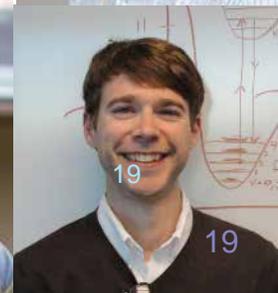
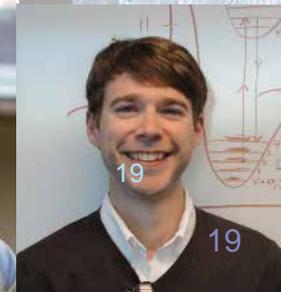
Kevin France, University of Colorado

2012:

Judd Bowman, Arizona State University

Michael McElwain, NASA GSFC

Randall McEntaffer, University of Iowa



2020 NASA Hubble Fellows



How does the universe work?
Einstein Fellows

How did we get here?
Hubble Fellows

Are we alone?
Sagan Fellows

<https://hubblesite.org/contents/news-releases/2020/news-2020-20>

<http://www.stsci.edu/stsci-research/fellowships/nasa-hubble-fellowship-program/2020-nhfp-fellows>

NASA Hubble Fellowship Program

Fellows are asking for the assurance of parental leave and the option of saving for their eventual retirement with the assistance of their employer.

Fellows who are employees of their host institutions typically have these benefits.

Stipendiary fellows do not receive employee benefits even though the NHFP is willing to pay the full cost of the employee benefits package.

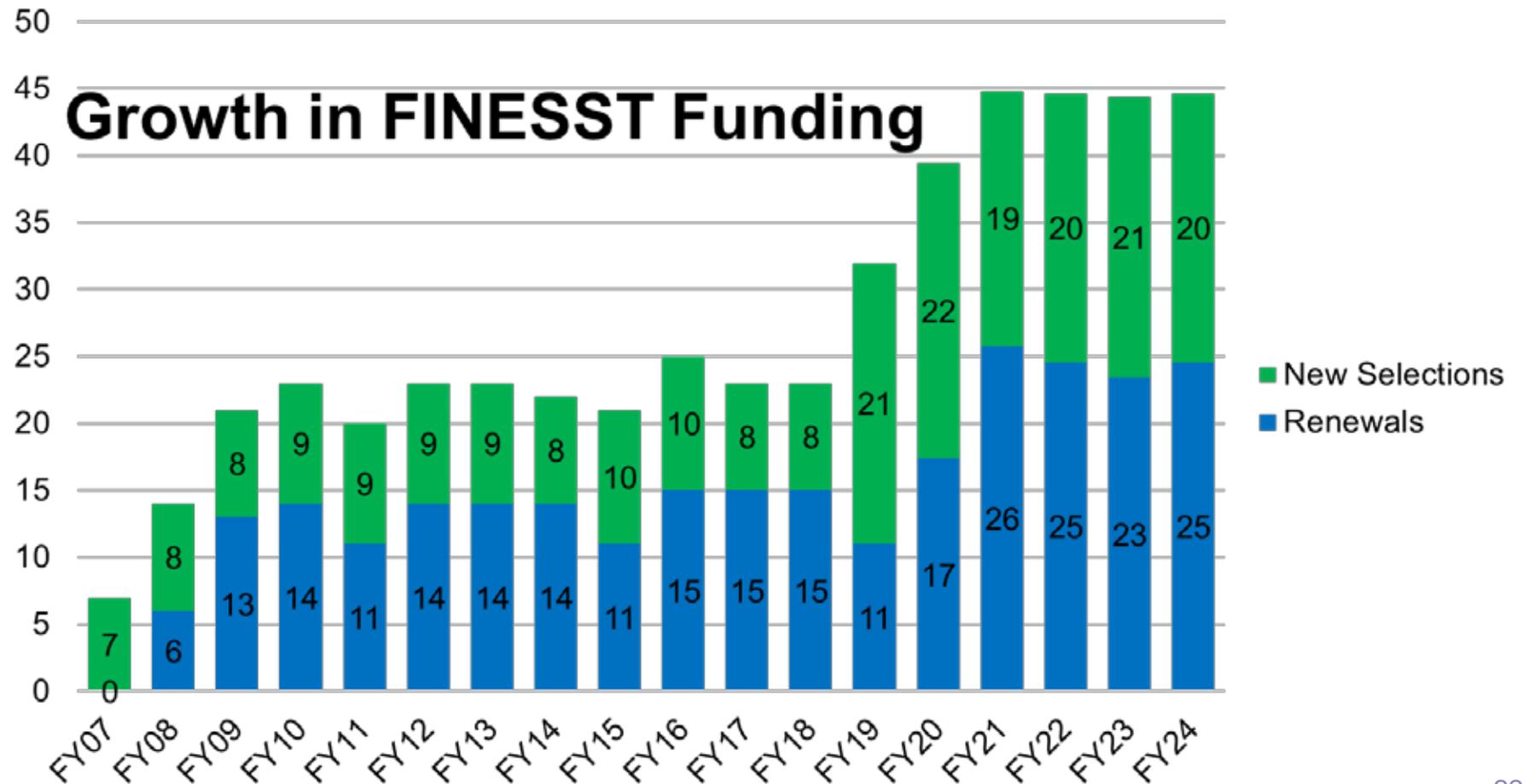
The Space Telescope Science Institute (STScI) has approved a change to the requirements for NHFP host institutions.

Starting with academic year 2022-2023, host institutions must offer their NHFP Fellows the opportunity to be employees. Employee status is being required to afford NHFP Fellows the same leave, vacation, retirement and health benefits (as applicable) given by these institutions to their postdoctoral fellows hired on grants or contracts as employees.

Direct any questions or comments on this policy to nhfp@stsci.edu

Graduate Student Research Awards

NASA Earth and Space Science Fellowship (NESSF) program name changed to Future Investigators in NASA Earth and Space Science and Technology (FINESST) in 2019 to more accurately capture the nature of awards.



Research and Analysis Initiatives



Dual Anonymous Peer Review

- SMD is strongly committed to ensuring that review of proposals is performed in an equitable and fair manner that reduces the impacts of any unconscious biases [next chart]

High-Risk/ High-Impact (HR/HI)

- To reinforce SMD's interest in High-Risk/High-Impact research, a special review process will be implemented in ROSES 2020 to review and select HR/HI proposals

Proposal Selection Metrics for ROSES 2018

- Overall, just under 50% of selections featured new PIs
- Majority of division selection rates were between 25 – 30%, and we are continuing to evaluate

Dual-Anonymous Peer Reviews in Astrophysics

NASA is strongly committed to ensuring that the review of proposals is performed in an equitable and fair manner that reduces or eliminates unconscious bias.

To this end, motivated by a successful pilot program conducted for the Hubble Space Telescope, all Astrophysics General Observer / General Investigator (GO/GI) proposals will be evaluated using dual-anonymous peer review.

In addition, the NASA Science Mission Directorate will conduct pilot programs in dual-anonymous peer review for non-GO/GI ROSES program elements in 2020.

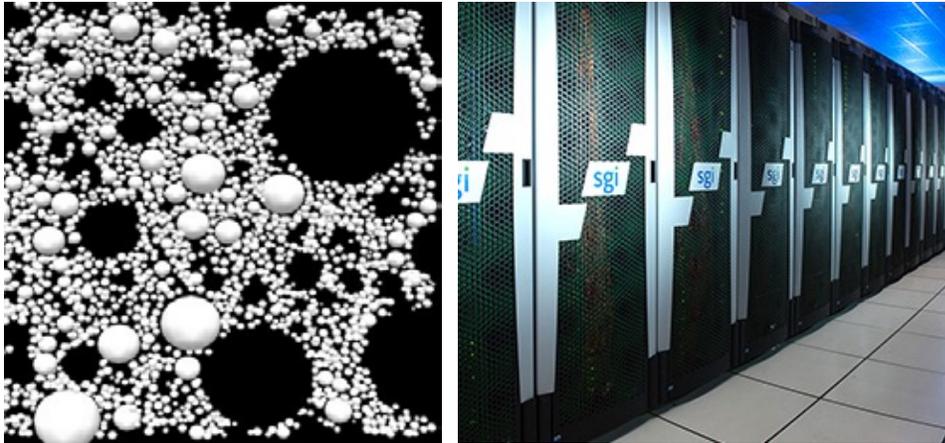
- One ROSES program element from each Division will be conducted in 2020 using dual-anonymous peer review.
- Proposals submitted to the Astrophysics Data Analysis Program and the Habitable Worlds Program in 2020 will be evaluated using dual-anonymous peer review.

Dual Anonymous Peer Review
Special Session
Tuesday June 2 @ 11:00 am EDT
Annie Jump Cannon Meeting Room

Rollout of Dual-Anonymous Reviews

Format	Program	Proposal due date
Traditional	NICER Cycle 2	11/13/2019 <input checked="" type="checkbox"/>
Traditional	TESS Cycle 3	1/16/2020 <input checked="" type="checkbox"/>
Dual-Anonymous <input checked="" type="checkbox"/>	NuSTAR Cycle 6	1/24/2020 <input checked="" type="checkbox"/>
Traditional	Fermi Cycle 13	2/19/2020 <input checked="" type="checkbox"/>
Dual-Anonymous <input checked="" type="checkbox"/>	Hubble Cycle 28	3/4/2020 <input checked="" type="checkbox"/>
Traditional	Chandra Cycle 22	3/17/2020 <input checked="" type="checkbox"/>
Dual-Anonymous	ADAP	6/30/2020
Dual-Anonymous	Webb Cycle 1	TBD
Dual-Anonymous	Swift Cycle 17	9/25/2020
Dual-Anonymous	NICER Cycle 3	11/12/2020
Dual-Anonymous	TESS Cycle 4	1/15/2021
Dual-Anonymous	NuSTAR Cycle 7	1/22/2021
Dual-Anonymous	Fermi Cycle 14	2/19/2021
Dual-Anonymous	Hubble Cycle 29	~3/2021
Dual-Anonymous	Chandra Cycle 23	~3/2021

Strategic Data Management



- SMD will be implementing changes to enable open data, open source code, and open model
- Informed by community input through multiple workshops, RFI, and NASEM reports
- Recognize that this will be a step wise process with the first changes coming in ROSES 2020 and upcoming Senior Reviews
- Periodic evaluation to ensure effectiveness and consistency with current best practices
- Additional information on SMD's data activities is available at:
<https://science.nasa.gov/researchers/science-data>



Why Volunteer to Serve on a NASA Peer Review Panel?

Personal professional development:

- See how the whole review process works

- Learn what constitutes excellent proposals

- Network with your professional colleagues and NASA scientific staff

Institutional achievement:

- Improve at competing for NASA money

- Increase knowledge of NASA's educational programs and research technology

Investment in the future:

- Help select the most transformative science

- Ensure that all proposals receive a fair and competent review

Sign up to be a panel reviewer:

<https://science.nasa.gov/researchers/volunteer-review-panels>



Keep Informed about NASA

NSPIRES mailing list – information about NASA solicitations

<https://nspires.nasaprs.com/>

Cosmic Origins mailing list, Exoplanet Exploration mailing list, Physics of the Cosmos mailing list – information about NASA missions and science

<https://cor.gsfc.nasa.gov/cornews-mailing-list.php>

<https://exoplanets.nasa.gov/exep/exopag/announcementList/>

<https://pcos.gsfc.nasa.gov/pcosnews-mailing-list.php>

NASA Astrophysics Federal Advisory Committees

Astrophysics Advisory Committee (APAC)

<https://science.nasa.gov/researchers/nac/science-advisory-committees/apac>

NAS Committee on Astronomy and Astrophysics (CAA)

http://sites.nationalacademies.org/bpa/bpa_048755

Astronomy and Astrophysics Advisory Committee (AAAC)

<https://www.nsf.gov/mps/ast/aaac.jsp>

Sign up to be a panel reviewer:

<https://science.nasa.gov/researchers/volunteer-review-panels>



NASA Astrophysics Research Program Update



R&A PROGRAMS

>1,000 Proposals Received
26% Success Rate
~\$100M Awarded Annually

TECHNOLOGY DEVELOPMENT

~\$140M Invested Annually

NEW PIs

>180 Per Year in R&A Prog
>120 Per Year in GO Prog

GO PROGRAMS

>2,000 Proposals Received
19% Success Rate
~\$70M Awarded Annually

CUBESATS

6 Current Programs
~1 Launch Per Year

SOUNDING ROCKETS

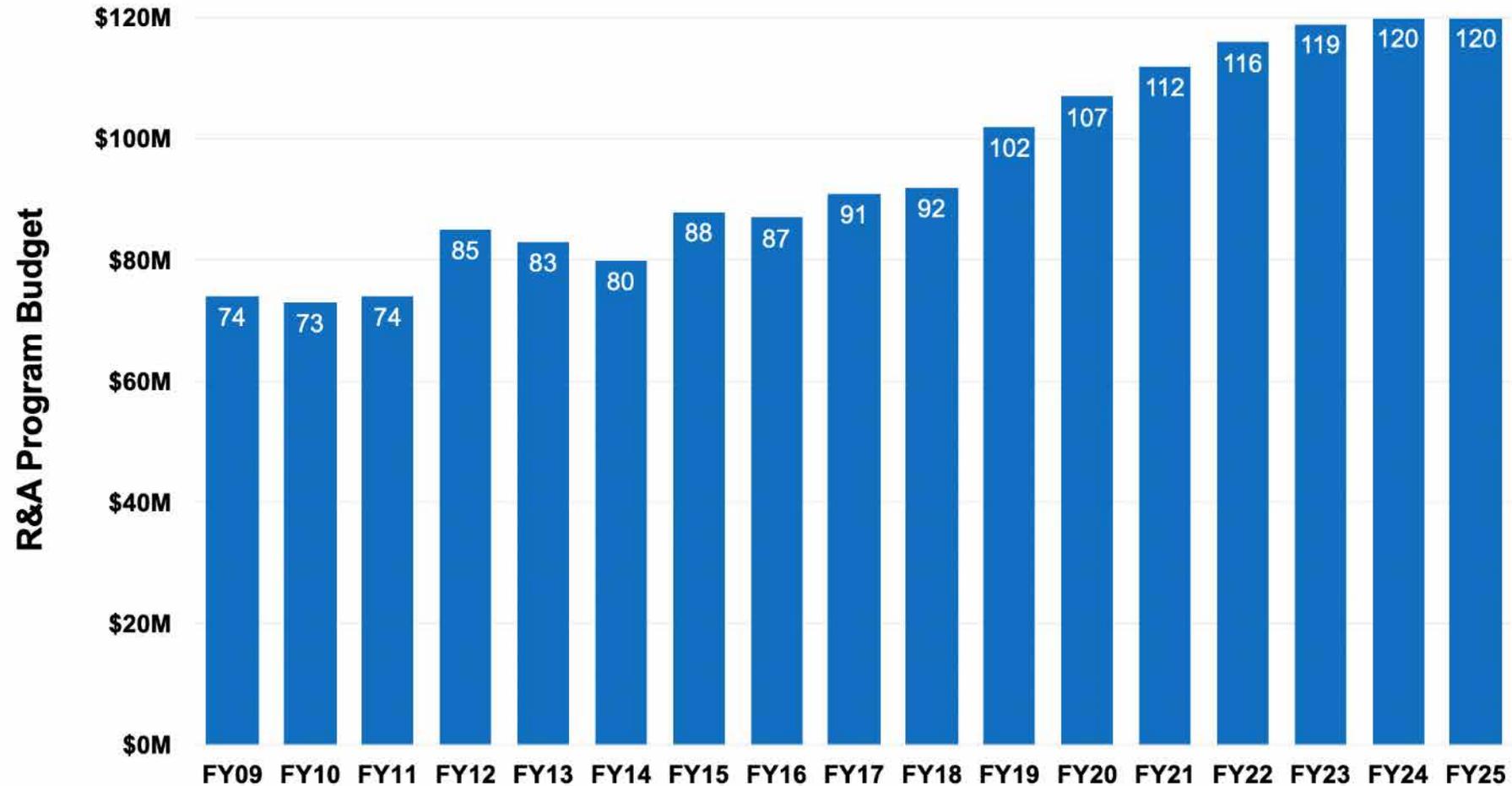
9 Current Programs
3-4 Launches Per Year

BALLOONS

18 Current Programs
3-6 Launches Per Year

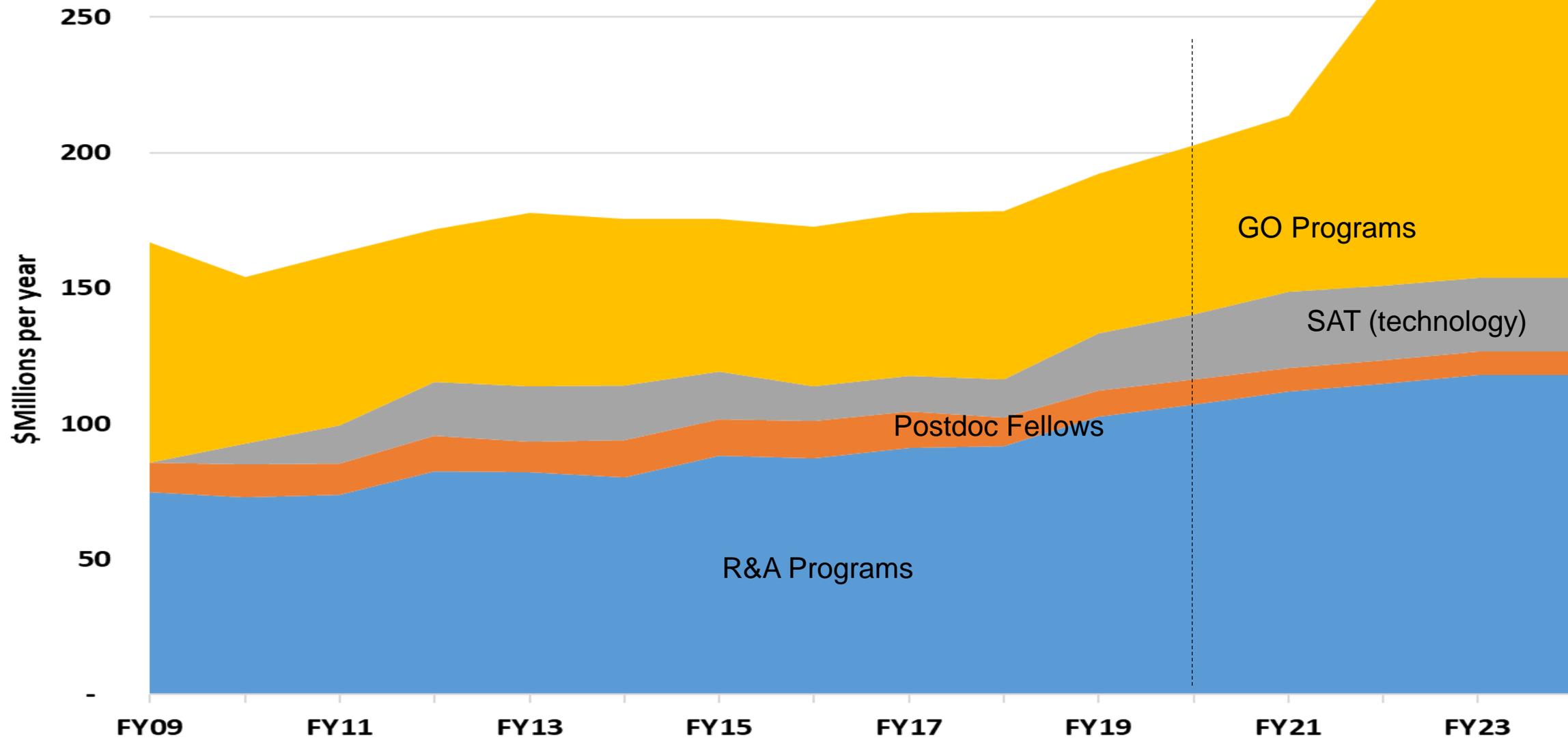
Astrophysics Research
by the
NUMBERS

R&A Research Funding



- R&A research funding increases by 54% over 17 years.

Astrophysics Community Funding



ROSES-2020 Program Elements

Supporting Research and Technology

- Astrophysics Research & Analysis (APRA), **includes Lab Astro equipment**
- ~~Strategic Astrophysics Technology (SAT)~~ **Canceled this year**
- Roman Technology Fellowships (RTF)
- Astrophysics Theory Program (ATP) (biennial, not this year)
- Theoretical and Computational Astrophysics Networks (TCAN) (triennial, this year)
- Exoplanet Research Program (XRP) (cross-div)
- **Topical Workshops, Symposia, and Conferences (TWSC)**

Data Analysis

- Astrophysics Data Analysis (ADAP)
- GO/GI programs for:
 - Fermi
 - Swift
 - NuSTAR
 - TESS
 - NICER

Mission Science and Instrumentation

- Sounding rocket, balloon, cubesat, and ISS payloads solicited through APRA
- **XRISM Guest Scientists**
- **LISA Preparatory Science**
- **Astrophysics Explorers U.S. Participating Investigators (triennial, this year)**
- **Astrophysics Pioneers**

Separately Solicited

- GO/GI/Archive/Theory programs for:
 - Chandra
 - Hubble
 - SOFIA
 - Webb
- NASA Hubble Fellowship Program
- NASA Postdoctoral Program
- FINESST Graduate Student Research Awards

New in ROSES-2020:

- SAT canceled in anticipation of the 2020 Decadal Survey
- Lab Astro equipment in APRA (see separate slide)
- Exoplanet Research Program consolidates exoplanet proposals (see separate slide)
- Astrophysics Pioneers (see separate slide)
- Astrophysics participates in cross-divisional TWSC
- XRISM Guest Scientist Program (one time)
- LISA Preparatory Science (one time)
- Astrophysics Explorers U.S. Participation Investigators (APEX USPI)
- Data Management Plan will be evaluated as part of the intrinsic merit of proposals

R&A Accommodation due to COVID-19

SMD is finalizing a process to provide limited adjustments to existing grants. Not all grants can be made whole, however

The focus will be on mitigating the impacts of the COVID-19 epidemic on the most vulnerable of us: graduate students, post-docs, and early career researchers in soft money positions

SMD does not want the COVID-19 epidemic to massively derail the careers of future leaders

Details will be made public by the end of June

SMD is considering options for helping SMD-funded, recently graduated PhDs and post-docs whose appointments are ending to weather the expected freeze in hiring by many research institutions

Review panels have all been converted to virtual events and are functioning well albeit in many cases taking longer than originally planned

This will be the norm until at least September

R&A Accommodation due to COVID-19

OMB has issued guidance; NASA has instituted a number of grant administration flexibilities to ease the burden on grant recipients during the COVID-19 emergency.

- Allows NASA to remove barriers for faster funding of grantees

- Allows for paying soft-money researchers as well as graduate students, post-docs, and other lab staff during the COVID-19 epidemic, if the institution's own policies allow for it

- Allows for institutions to charge restart costs to their grants

- Provides agencies flexibility with regard to the submission of proposals, including accepting late proposals

FAQs to help you navigate:

- SMD COVID-19 Grants FAQ: <https://science.nasa.gov/researchers/sara/library-and-useful-links>

- NASA FAQ on Grants and Research during the COVID-19 Epidemic:

 - <https://www.nssc.nasa.gov/grants>

- OMB guidance in Memo M-20-17: <https://www.whitehouse.gov/wp-content/uploads/2020/03/M-20-17.pdf>

- NRESS Virtual Panel Meetings Support:

 - <https://nspires.nasaprs.com/tutorials/infoPage/virtualSupport.html>

Watch the NSPIRES email lists for up-to-the-minute changes in due dates or policies

R&A Accommodation due to COVID-19

R&A management at NASA HQ continues via telework

No ROSES-20 astrophysics solicitations have been canceled due to COVID-19

ADAP will not be offered in 2021 to reduce the community workload next year as we recover from the impacts of COVID-19

Two ROSES-20 solicitations (TCAN, ADAP) have moved proposal due dates into late June to provide proposers additional preparation time

Five Astrophysics R&A peer reviews have already been conducted as virtual reviews since March, with no adverse effect on quality of reviews

All peer reviews until at least September are being conducted virtually

Astrophysics Data Analysis Program

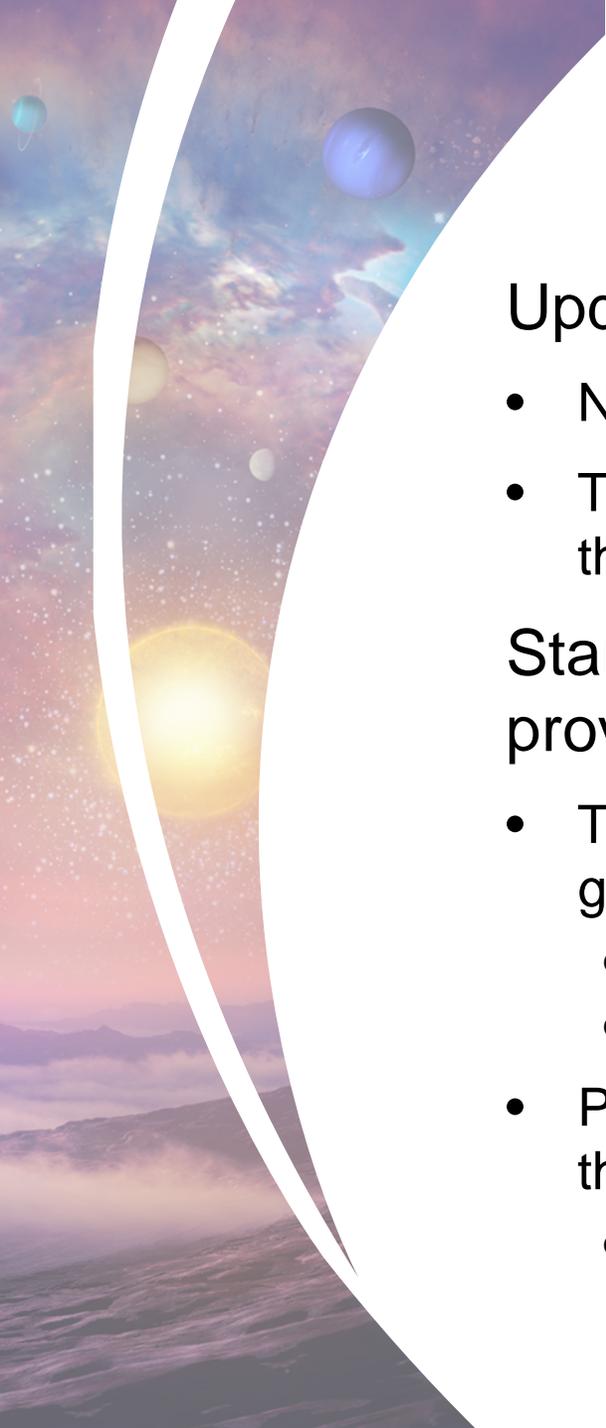
ADAP will not be offered in 2021 to reduce the community workload next year as we recover from the impacts of COVID-19: focus our efforts without reducing opportunity space

- All of the funding planned for selections in both 2020 and 2021 will be committed in 2020 – no reduction in funding to the community
- The number of selected proposals will approximately double
- This allows more awardees to be assured of funding this year
- This reduces the work for both NASA and the community without reducing the opportunity space for community funding
- No change to plan for ADAP to be dual anonymous this year

Proposals due June 30, 2020

Community comment is sought

- COPAG conducted a survey (<https://forms.gle/hyrxTzHi8z5UCQGP8> by June 5)
- APAC will discuss at their June 23-24 meeting



Lab Astro Equipment Initiative

Updating and maintaining existing laboratories is a critical need:

- New science requires new and improved laboratory systems.
- The number, complexity, and energy range of NASA lab astro programs and their associated data needs continue to grow.

Starting in ROSES-20, a new Lab Astro Equipment Initiative provides additional funding to support lab equipment proposals.

- This initiative is not intended to support building of new complete labs. The goal is to:
 - Enable new science with new equipment
 - Replace and/or upgrade failing equipment
- Proposals that request Lab Astro equipment upgrades can be submitted through APRA with proposals due on December 17
 - ROSES-20 D.3 APRA will be amended within the next few weeks

Exoplanet Research Program Consolidation

Purpose: combine skills and disciplines from across divisional boundaries and scientific cultures to make the most impact upon strategic and solicited exoplanet science

- Starting in ROSES-20, the scope of Astrophysics ROSES Appendix D is changing to exclude exoplanet research elements from ADAP, ATP, and the Lab Astro component of APRA. Technology development within APRA will not be affected.
- Historical levels of APD exoplanet research funded through ADAP, ATP, and APRA will be maintained, but distributed through XRP.
- In addition to Planetary Science Division, Heliophysics Division and Earth Science Division are now financial partners in XRP, increasing the total funding available to the program.
- As a result, the funding allocation for XRP increases substantially

FY20	FY21	FY22	FY23
\$8.9M	\$10.2M	\$11.6M	\$12.7M
	+15%	+30%	+43%

Citizen Science

Citizen Science (CS) is a form of open collaboration in which individuals participate voluntarily in the scientific process

Current projects at <https://science.nasa.gov/citizenscience>

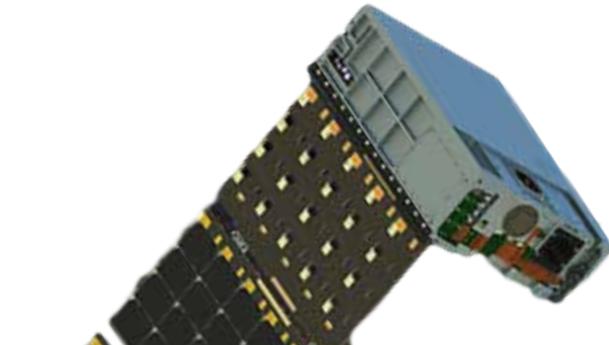
Proposers to any ROSES program element may incorporate citizen science and crowdsourcing methodologies into proposals, where such methodologies advance the proposed investigation

NASA Citizen Science Community Workshop series online every other Wednesday until September 30, 2020, at <https://nasacitsci2020.gmri.org/home>

NASA's Astrophysics, Heliophysics, and Planetary Science Divisions will release a joint ROSES-20 program element for a Citizen Science Seed Funding Program to fund prototyping of citizen science projects relevant to the three Divisions

NASA Astrophysics CubeSats

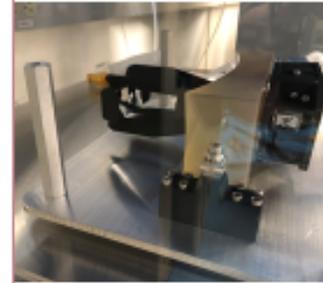
The Astrophysics Division is investing approximately \$5M per year in a CubeSat initiative.



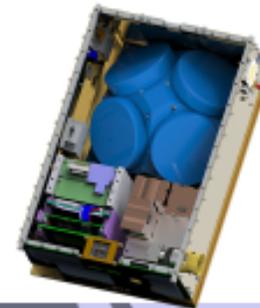
- **HaloSat**, PI: Phil Kaaret, U. Iowa
- **Science Objectives:** HaloSat is mapping soft X-ray oxygen line emission across the sky in order to constrain the mass and spatial distribution of hot gas in the Milky Way.
- **Technologies:** BCT S/C, COTS detectors, collimators with no optics.
- **Deployed:** Jul 13, 2018, from ISS

Astrophysics CubeSats in Development

- **CUTE**, PI: Kevin France, CU
- **Science Objectives:** The Colorado Ultraviolet Transit Experiment (CUTE) will take medium resolution UV spectra of 14 hot Jupiters during transit, in order to measure atmosphere being ablated away.
Technologies: BCT S/C, COTS telescope and camera.
- **Launch:** 2021 on LandSat-9

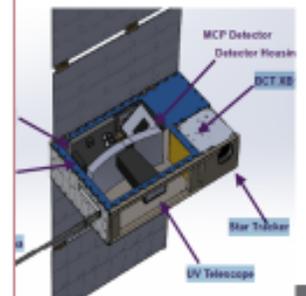


- **BlackCat**, PI: Abe Falcone, Penn St.
- **Science Objectives:** GRB/Transient detection in 0.2-20keV with coded mask.
- **Technologies:** CMOS x-ray CCD
- **Launch:** FY2024



- **BurstCube**, PI: Jeremy Perkins (GSFC)
- **Science Objectives:** Rapid localizations for LIGO/Virgo detections with short GRBs; Search of g-ray transients.
- **Technologies:** Dillinger derived bus, Fermi-GBM like detectors.
- **Launch:** Fall 2021

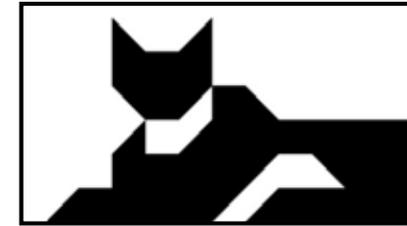
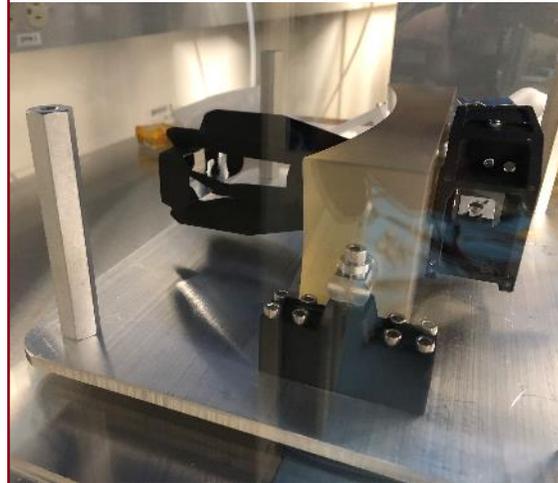
- **SPRITE**, PI: Brian Fleming, CU
- **Science Objectives:** Determine ionization rate of IGM from galaxies and AGN, trace feedback within galaxies driven by star-forming regions, using low-resolution imaging UV spectrograph.
- **Technologies:** in house S/C, UV coatings, next-gen MCP.
- **Launch:** Fall 2022



CubeSat proposals may be submitted to APRA, due date December 17

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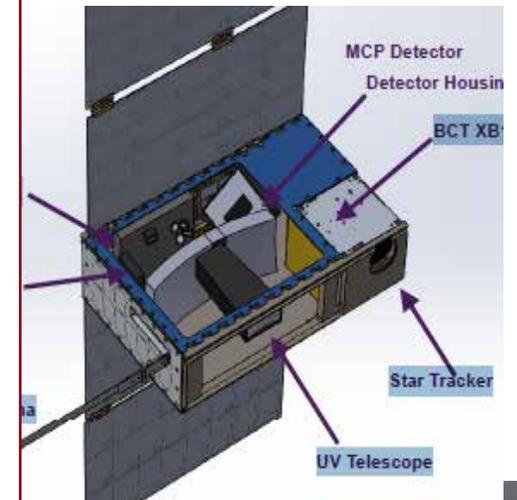


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Astrophysics Pioneers

The FY21 President's Budget Request contains a new initiative for Astrophysics – Astrophysics Pioneers: A new class of small missions

Fills the gap between existing ROSES investigations (<\$10M for APRA) and existing Explorers MO investigations (<\$35M for SmallSats)

Includes SmallSats, Large CubeSats (> 6U), CubeSat constellations (all as rideshare/secondary payloads), major balloon missions, and ISS attached payloads with a \$20M cost cap, not including launch

Managed as Research and Analysis projects with enhanced oversight, defined gates, and light touch management from NASA, rather than flight project processes appropriate for a SMEX

NASA will no longer solicit ISS attached payloads within APRA

NASA will no longer solicit balloon payloads within Explorers MO

Draft released May 14, Comments due June 15 via email to

Michael.R.Garcia@nasa.gov

Astrophysics Technology Program Elements

Technology Inception & Experimentation APRA/RTF

- 46 projects awarded in 2019
- Solicitations planned in FY20, delayed 9 months
- Average award: \$600K (3-5 years)
- Average selection rate: 28%
- Portfolio:
 - Supporting 19 Balloons and 10 Sounding Rockets Payloads
 - Detectors across wavelengths
 - Mirrors, coatings and gratings

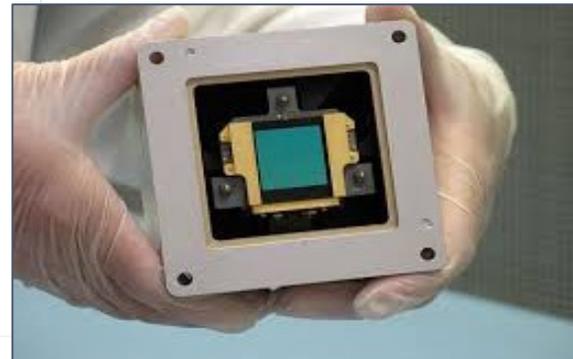
Total: \$50 M per year



Technology Maturation SAT & ISFM

Unified solicitation and selection starting in FY19 for the three Astrophysics themes. Portfolio has 49 active projects for a total of \$28 M per year.

- 12 new projects awarded in FY19
- Next solicitation planned in FY20, currently TBD
- Average award: \$1.6M (3 years)
- Average selection rate: 30% (in FY19, historically is 29%)



Directed Technologies

- Roman Coronagraph
- Exoplanets Probes: Exo-C & Exo-S
- LISA
- Athena
- Euclid
- NN-Explore – NEID
- SmallSats and CubeSats

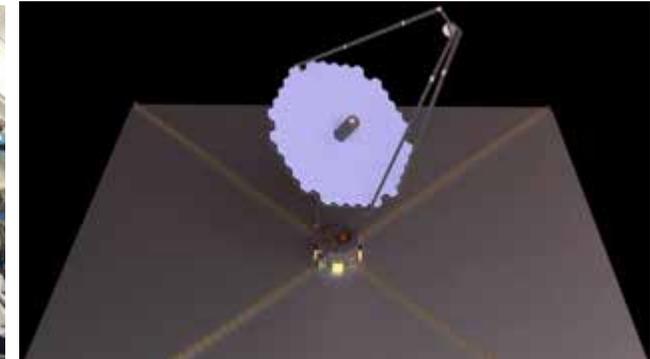
Total: \$85 M in FY19



Pre-Decadal Initiatives

- In-Space Assembled Telescope (iSAT)
- Coronagraph and UltraStable Testbeds
- Starshade Technology
- Four Large Mission Concepts – Technology Roadmaps
- Ten Probe Mission Concepts
- Segmented Mirror Telescope Program (STMP)

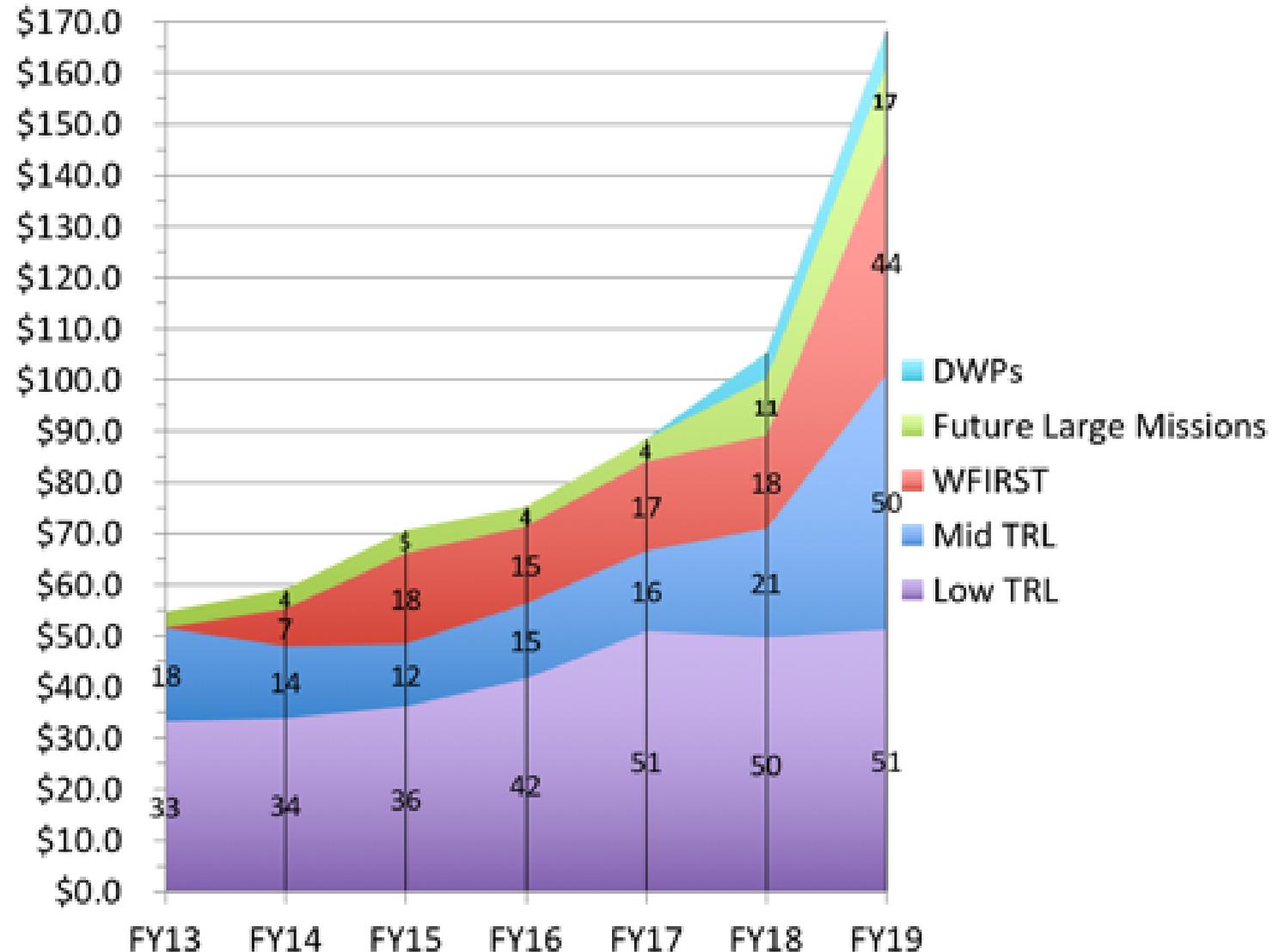
Total: \$25 M in FY19



Astrophysics Technology Program Elements

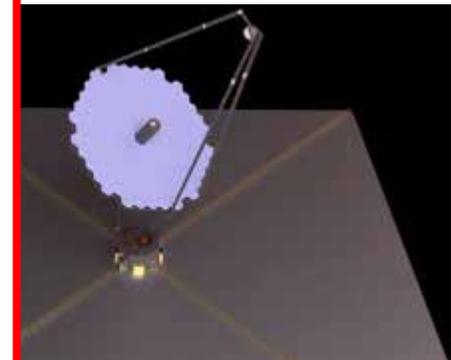
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 - Average award: \$600K (3-5 year)
 - Average selection rate: 28%
 - Portfolio:
 - Supporting 19 Balloons
 - Sounding Rockets Payloads
 - Detectors across wavebands
 - Mirrors, coatings and gratings
- Total: \$50 M per year

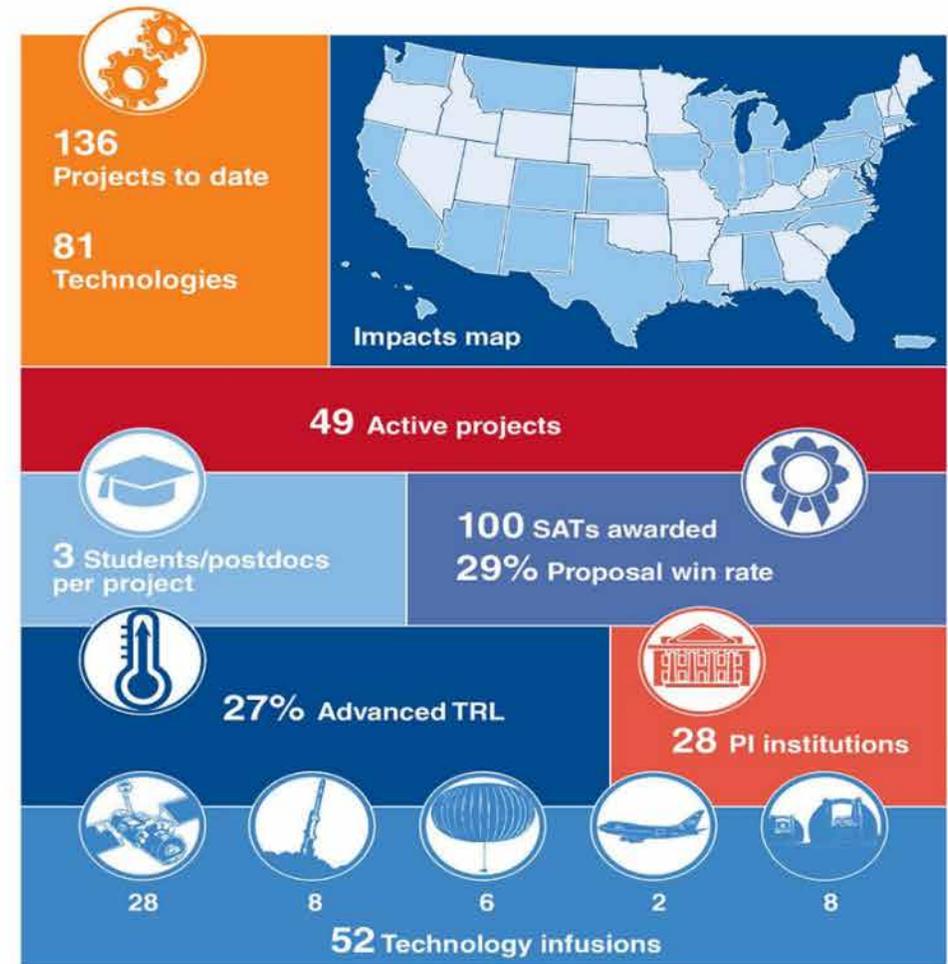
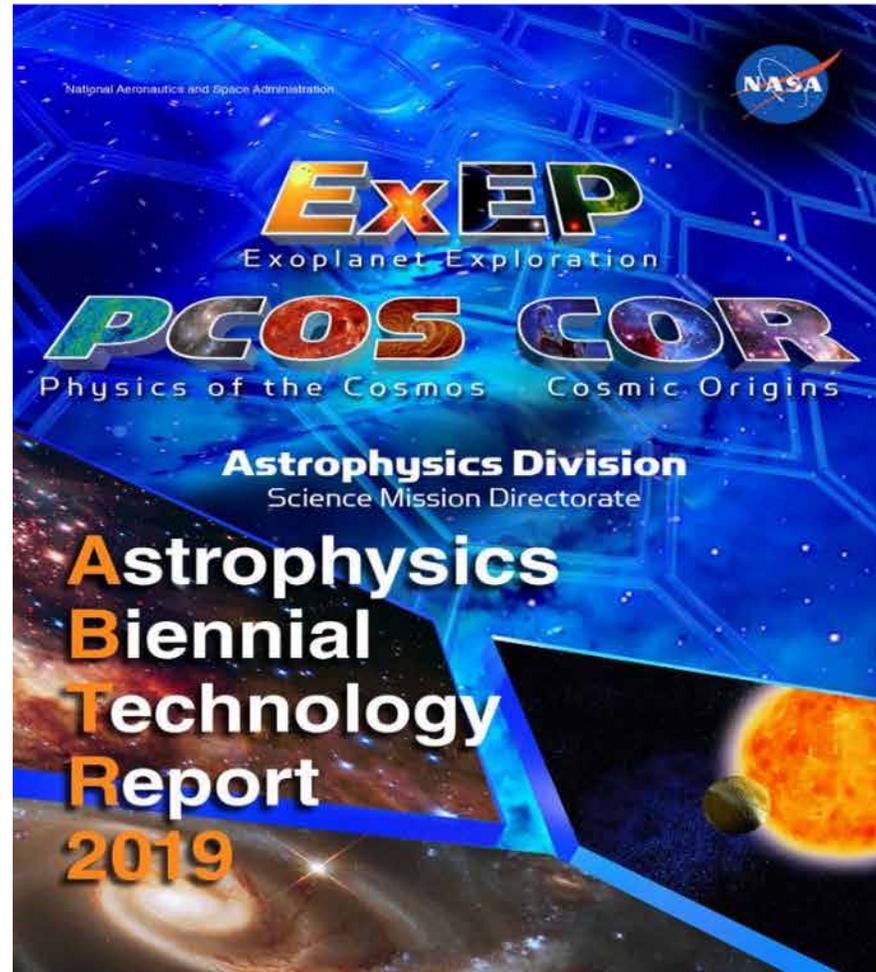


Strategic Initiatives

- Space Assembled Telescope
- Graph and UltraStable
- Precision
- Space Technology
- Large Mission Concepts –
- Technology Roadmaps
- Probe Mission Concepts
- Segmented Mirror Telescope
- Program (STMP)
- STMP in FY19



Integrated Strategic Technology Portfolio



Astrophysics Biennial Technology Report: <https://apd440.gsfc.nasa.gov/technology.html>

Database of Astrophysics technology projects: <http://www.astrostrategictech.us/>



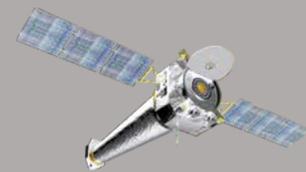
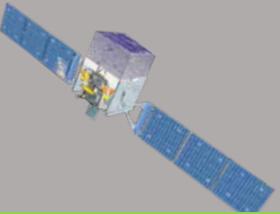
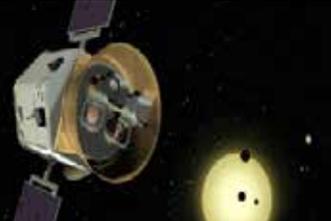
NASA Astrophysics Missions Program Update



Coronavirus (COVID-19) Response – Missions

- Missions in operation continue nominally
 - Most MOC and SOC staff working virtually
 - SOFIA currently grounded, but planned maintenance has resumed
 - Space Communications Program continues to support uplinks/downlinks and has a plan in place if local conditions at network sites affect communications capabilities
- Missions in development are doing as much as they can virtually right now
 - Suspended most hands-on work within NASA, including suborbital research
 - Work is being restarted at NASA Centers on a case-by-case basis when it can be done safely
 - Many of NASA's contractors and partners have continued to work safely
- Prioritizing Mars 2020 as it is close to launch
 - James Webb Space Telescope also continues to be a priority
 - Although the NASA portion of the NASA/NGSS team returned home mid-March, and I&T at NGSS had reduced shifts, NASA staff have now returned to NGSS and two shifts will be started soon; Observatory I&T continues making progress

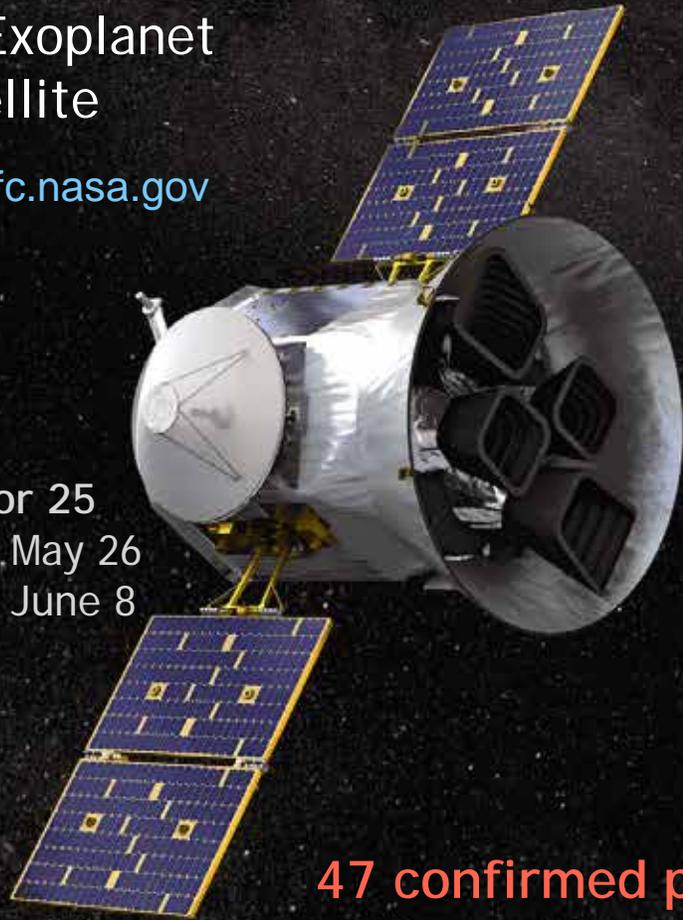
Astrophysics Operating Missions

<p>Hubble ^{4/90} NASA Strategic Mission</p>  <p>Operations Nominal</p>	<p>Chandra ^{7/99} NASA Strategic Mission</p>  <p>Operations Nominal</p>	<p>XMM-Newton ^{12/99} ESA-led Mission</p>  <p>Operations Nominal (ESA)</p>	<p>Spitzer ^{8/03} NASA Strategic Mission</p>  <p>Mission Complete!</p>	<p>Gehrels Swift ^{11/04} NASA MIDEX Mission</p>  <p>Operations Nominal</p>	<p>Fermi ^{6/08} NASA Strategic Mission</p>  <p>Operations Nominal</p>
<p>Kepler ^{3/09} NASA Discovery Mission</p>  <p>Mission Complete!</p>	<p>NuSTAR ^{6/12} NASA SMEX Mission</p>  <p>Operations Nominal</p>	<p>SOFIA ^{5/14} NASA Strategic Mission</p>  <p>Operations Suspended</p>	<p>ISS-NICER ^{6/17} NASA Explorers Miss. of Oppty</p>  <p>Operations Nominal</p>	<p>TESS ^{4/18} NASA MIDEX Mission</p>  <p>Operations Nominal</p>	<p>Data Archives HEASARC, IPAC, MAST, etc.</p>  <p>Operations Nominal</p>

TESS

Transiting Exoplanet
Survey Satellite

<https://tess.gsfc.nasa.gov>

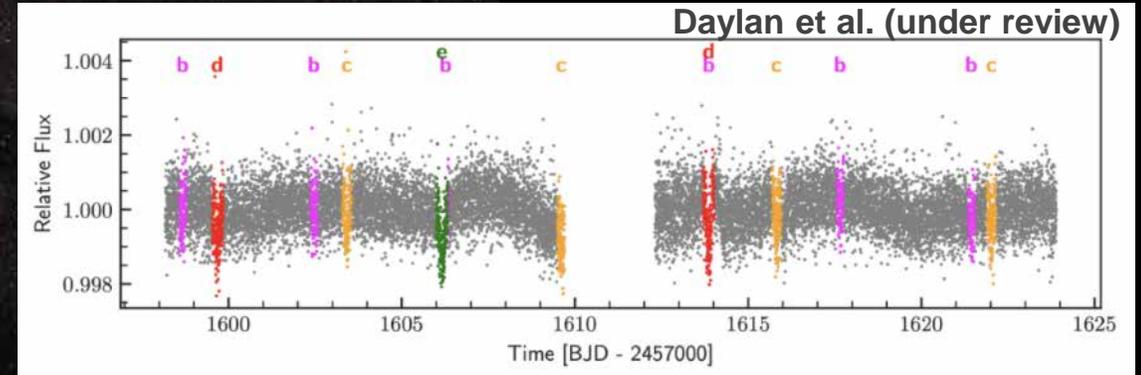


47 confirmed planets
1837 planet candidates

280 publications submitted, 214 peer-reviewed
(53% exoplanets, 47% astrophysics)

Four-planet system orbiting a bright Sun-like star

HD 108236 (TOI-1233)

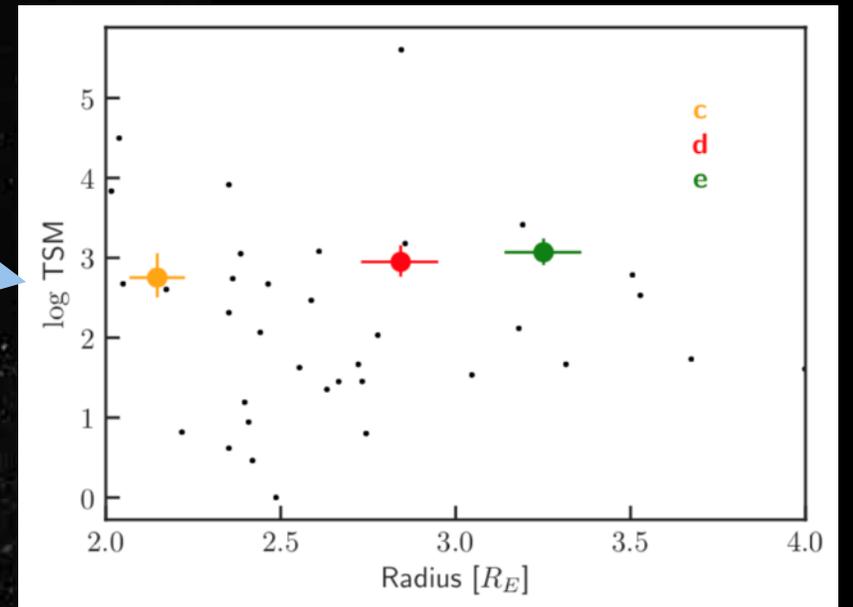


Brightest sun-like star to host 4 transiting planets. Three outer planets are among the best JWST sub-Neptunes for spectroscopy:

Transmission
Spectrum Metric
TSM

High TSM = great
JWST target

Daylan et al.
(2020)



SOFIA Stratospheric Observatory for Infrared Astronomy



SOFIA began its extended mission in October 2019, and suspended flight operations in March 2020 due to COVID-19

SOFIA Project has implemented major initiatives to improve scientific productivity and impact

Legacy programs are larger fraction of the total observing time

Two legacy programs scheduled in Summer 2020 from New Zealand

Joint project and synergies implemented with other NASA missions and observatories:

- Mapping water on Moon in support of VIPER/Artemis mission
- SOFIA Cycle 9 to support JWST ERS programs
- Joint Hubble-SOFIA pilot demonstration program (exploring)
- Joint Green Bank Observatory – SOFIA proposals (under final review)

More strategic use of the Director's Discretionary Time

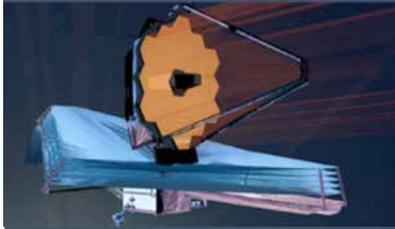
- e.g., recent Betelgeuse observing campaign using four SOFIA instruments; Moon pilot legacy program

Higher program completion rate by moving to a two-year scheduling cycle; potentially increasing observing opportunities

"Community Update", led by Margaret Meixner, Director of SOFIA Science Mission Operations, AAS webinar: Tuesday June 2 @ 3 pm EDT

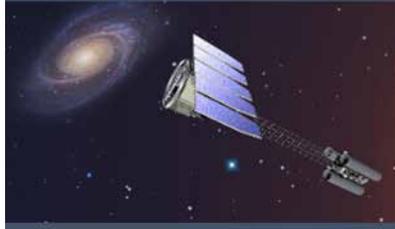
Astrophysics Missions in Development

Webb 2021
NASA Mission



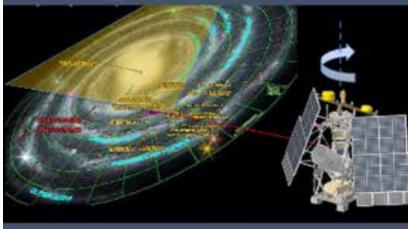
James Webb
Space Telescope

IXPE 2021
NASA Mission



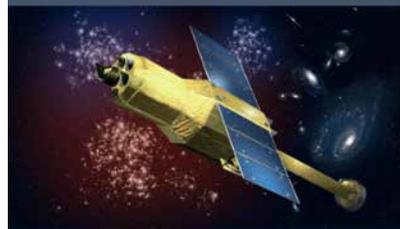
Imaging X-ray
Polarimetry Explorer

GUSTO 2021
NASA Mission



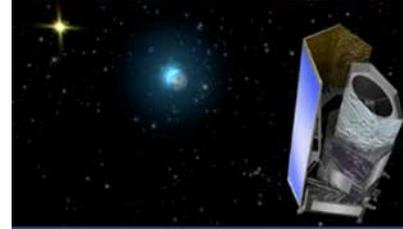
Galactic/ Extragalactic ULDB
Spectroscopic Terahertz Observatory

XRISM 2022
JAXA-led Mission



NASA is supplying the SXS
Detectors, ADRs, and SXTs

Euclid 2022
ESA-led Mission



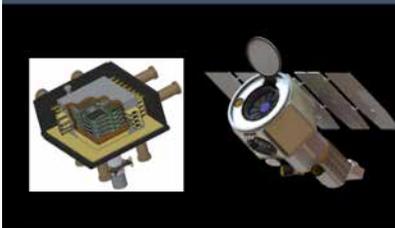
NASA is supplying the NISP
Sensor Chip System (SCS)

SPHEREx 2023
NASA Mission



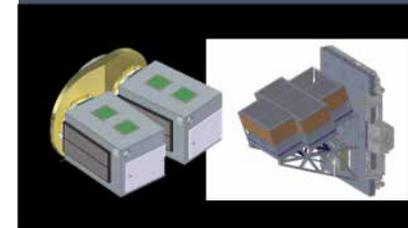
Spectro-Photometer for the History of
the Universe, Epoch of Reionization,
and Ices Explorer

SMEX ~2025
NASA Mission



COSI or ESCAPE

Mission of Opportunity ~2025
NASA Mission



Dorado or LEAP

Roman 2025
NASA Mission



Nancy Grace Roman
Space Telescope

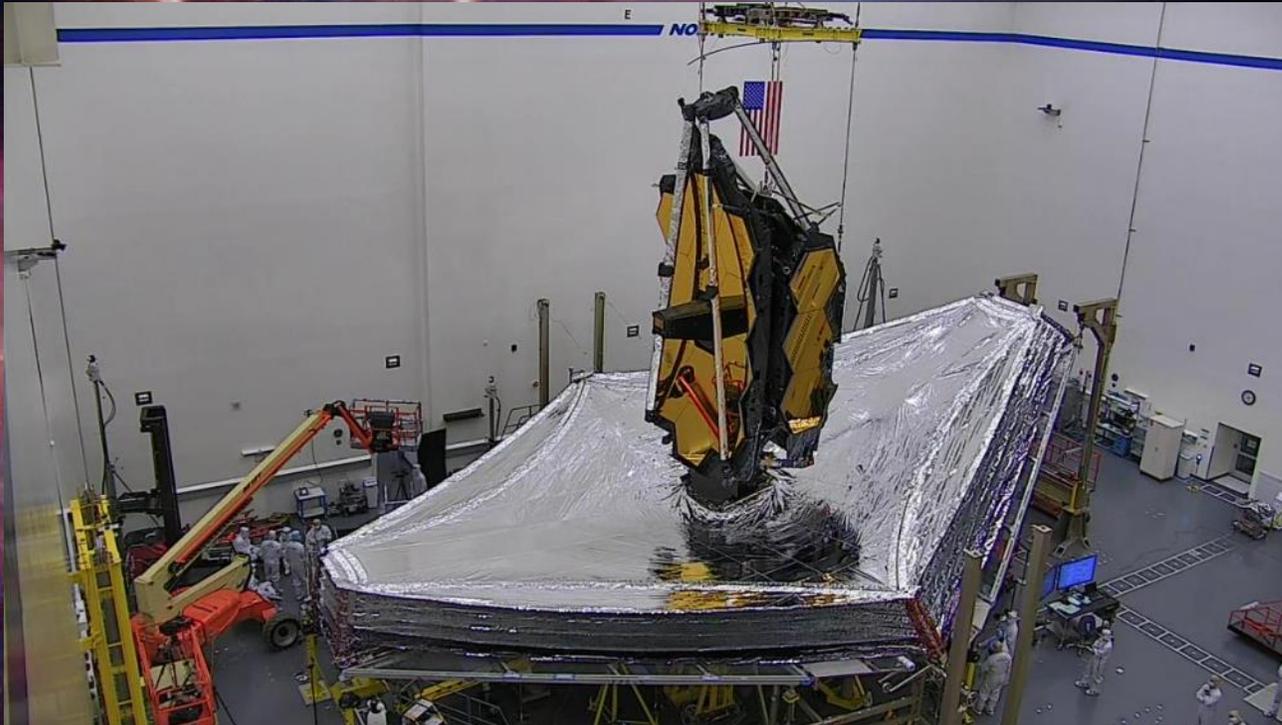
ARIEL 2028
ESA-led Mission



NASA is supplying the CASE
fine guidance instrument

Launch dates are current project working dates; Agency Baseline Commitment launch date could be later; impacts of COVID-19 not yet known

“James Webb Space Telescope Overview”,
led by Jonathan Gardner (GSFC) and Klaus Pontoppidan
(STScI), AAS webinar:
Tuesday June 2 @ 2:00 pm EDT, Exhibit Hall



The Webb observatory in the clean room in Redondo Beach, CA in August 2019

Webb

The James Webb Space Telescope



2020 Accomplishments

- Work continuing at Northrop, but at lower efficiency due to social distancing practices required by COVID19 response.
- Completing deployment test in preparation for Observatory-level environmental tests
- Conducted several mission rehearsals at the mission operation center (STScI)

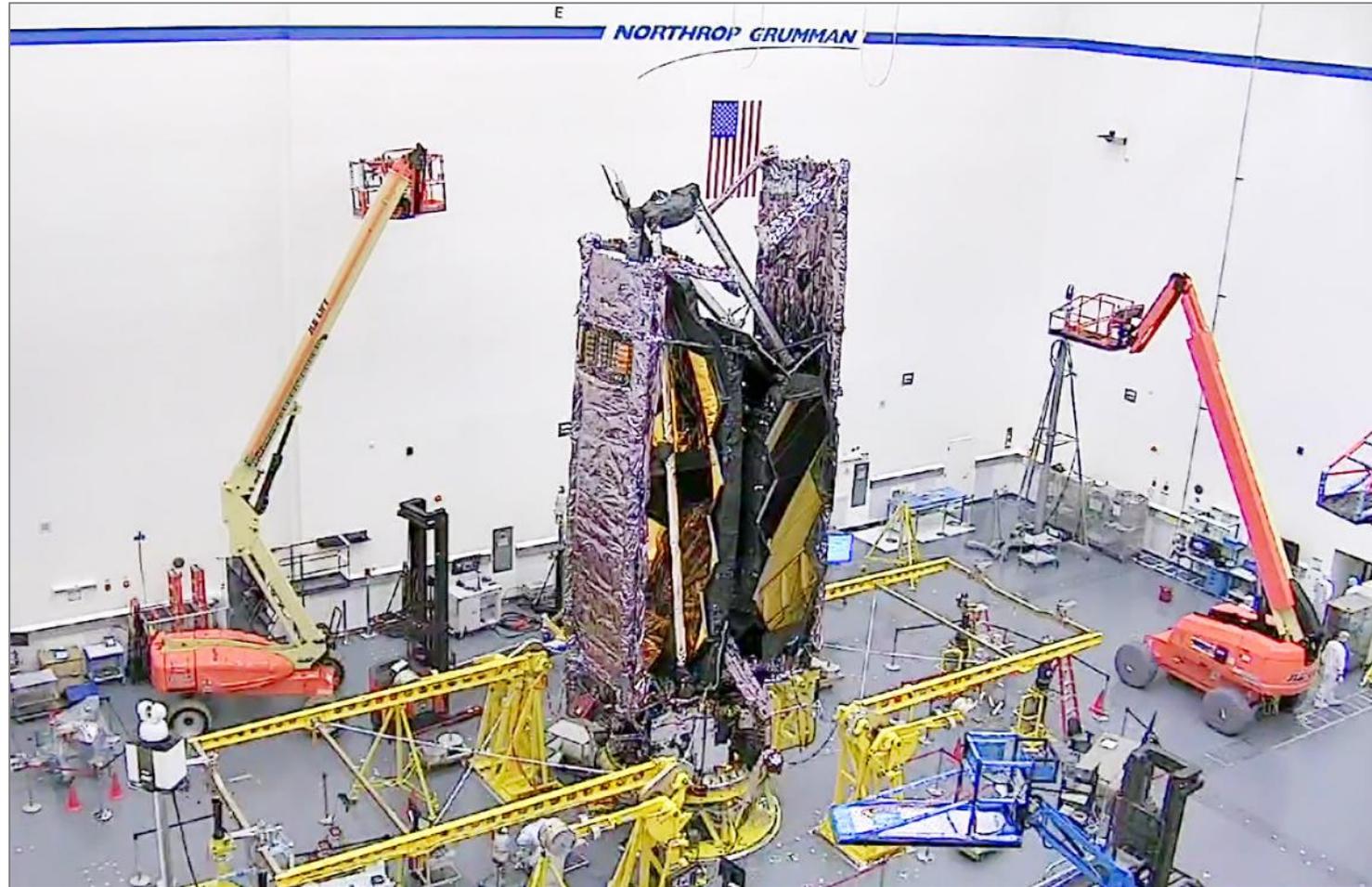
2020 Remaining Plans

- After coming out of COVID19 response restrictions project will formally evaluate schedule
- Observatory-level environmental testing
- Post Observatory-level environmental testing deployments
- Additional mission rehearsals at STScI
- Release of Cycle 1 General Observer call

Webb Final Assembly

Space Telescope Science Institute (STScI) Town Hall: Tuesday June 2 @ 1:40 pm, Annie Jump Cannon Meeting Room

- No schedule for Webb Cycle 1 GO/AR proposals has been announced.
- An update on the schedule will be announced in mid- to late-July.
- At least 12 weeks notice of the proposal deadline will be provided.



The fully assembled and folded observatory at Northrop Grumman, Space Park (May 2020). This is the configuration that Webb will be in when it is mated to the Ariane 5 launch vehicle in 2021. After environmental testing in this configuration it undergoes one more set of deployment testing (primary mirror and sunshield) before a final fold back into this configuration.

Roman Space Telescope

(formerly Wide-Field Infrared Survey Telescope)

Confirmed and entered
Phase C on Feb 28, 2020

<https://www.nasa.gov/feature/nasa-approves-development-of-universe-studying-planet-finding-mission>

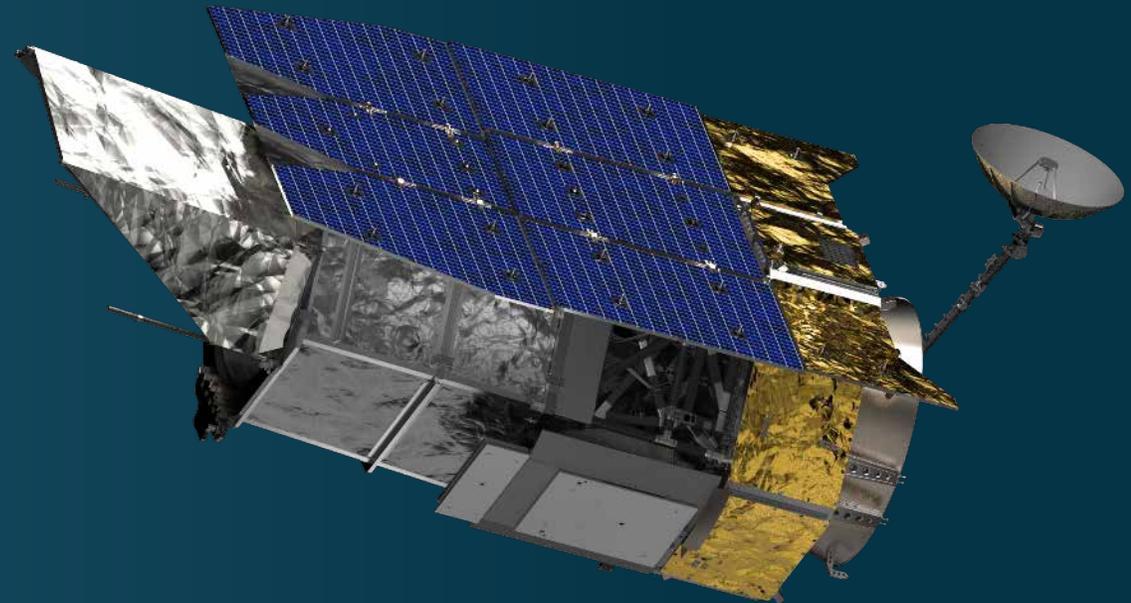
Roman is fully funded in FY20

2020: Flight hardware being developed:
mirror being figured, detectors being
fabricated, spacecraft subsystems being
delivered, coronagraph demo unit in
testbed

2021 – Complete Critical Design Reviews

c.2026 – Launch

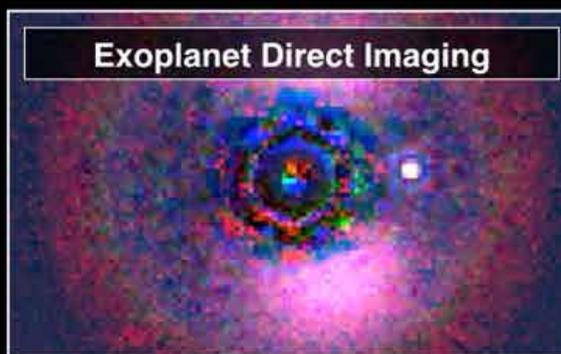
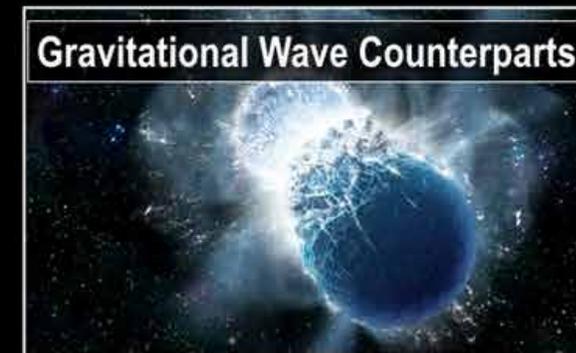
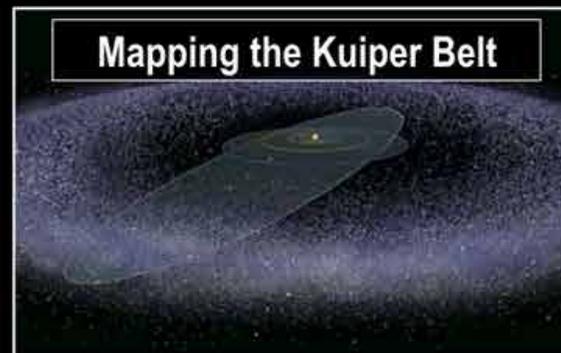
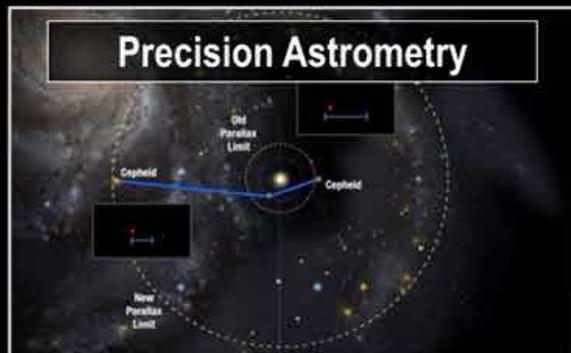
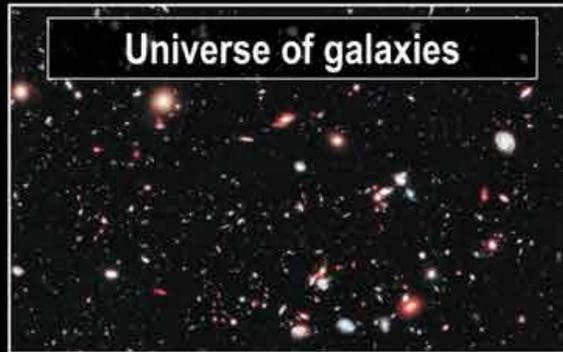
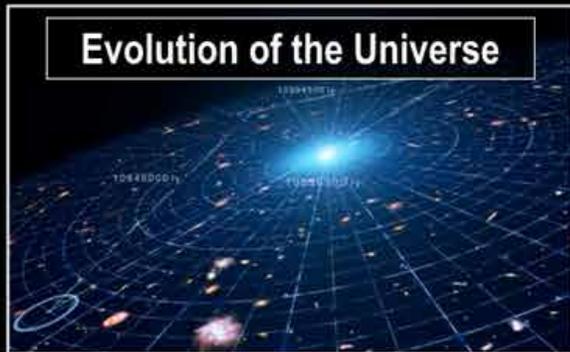
<https://www.nasa.gov/press-release/nasa-telescope-named-for-mother-of-hubble-nancy-grace-roman>



Roman field-of-view is 100× *Hubble* field-of-view

Roman is 100 to 1500 times faster than *Hubble* for large
surveys at equivalent area and depth

“Your Next Flagship: the Roman Space Telescope”, led
by Dominic Benford, Roman Program Scientist, AAS
webinar: Monday June 1 @ 3:30 pm EDT, Exhibit Hall



Roman will impact almost every area of astrophysics for almost every astronomer

Roman Update

On February 28, 2020, *Roman* passed the Confirmation Review (KDP-C) and was approved by the Agency Program Management Council to begin implementation (Phase C in NASA terminology)

Only change is Coronagraph Technology Demonstration Instrument (CGI) programmatic status

- CGI is being managed like other SMD technology demonstration projects (Mars Helicopter, Deep Space Optical Communications)

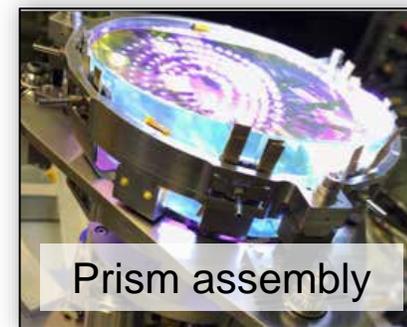
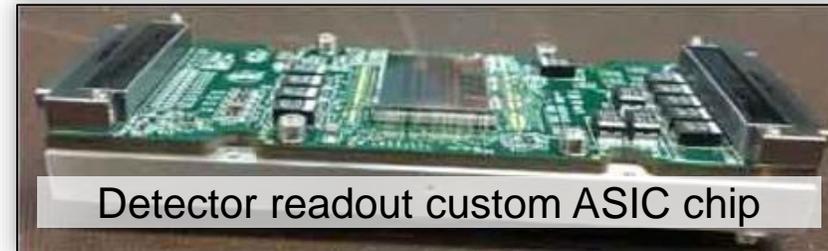
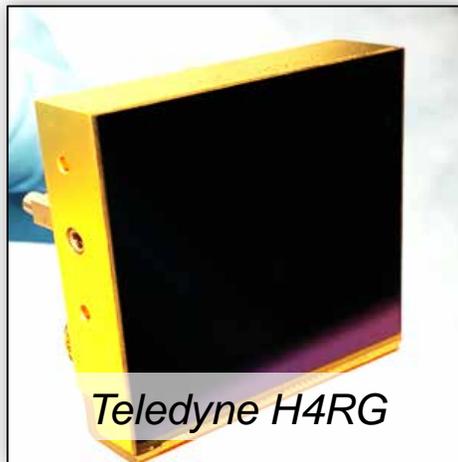
Roman has an expected development cost of \$3.2 billion. Including the cost of five years of operations and science, and CGI (\$334M), brings the maximum cost of *Roman* to \$3.934 billion.

Cost and schedule commitments are unchanged since initial confirmation in 2018 (KDP-B or Phase B in NASA terminology)

COVID-19 update:

- Currently limited on-site work is taking place at GSFC and JPL per NASA Framework
- Work continues at several contractors, consistent with local situations

Roman Hardware Progress



Telescope

Instruments



Roman is for You

All *Roman* observing time is available through open processes

- Major Legacy Surveys defined using a community-driven open process in the coming year
- Key Projects – science investigations using these surveys – will be openly competed
- *Roman* observing time also available for GO projects using *Roman*'s unique wide-field imaging, spectroscopic, and time domain capabilities
- All data will be available to the community with no period of limited access

Roman observing program will be based on community input

- NASA and STScI have convened community groups to provide input on balance among observing programs and on trades during development, integration, and test

Roman General Observers / Archival Researchers Program

- Use *Roman* for conducting wide-field infrared surveys of the universe
- Use data from *Roman* Legacy Surveys for compelling astrophysics investigations
- Calls for proposals to be issued before launch and subsequently

Roman Coronagraph Participating Scientist Program

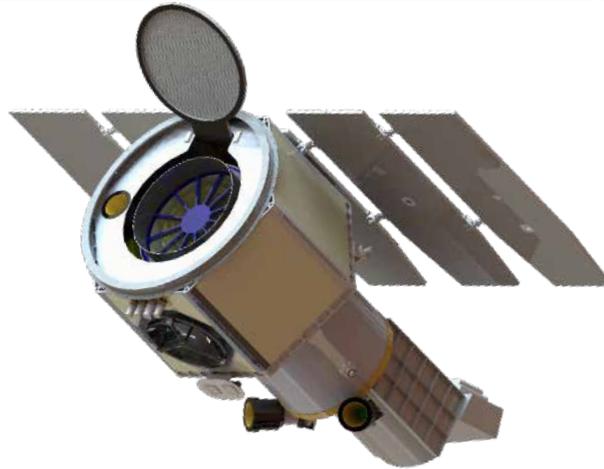
- Develop observing plans for demonstrating coronagraph capabilities
- Work with instrument team to process data from tech demo observations
- Call for proposals anticipated in the coming year

Astrophysics Explorers in Competitive Phase A

Small Explorers

ESCAPE

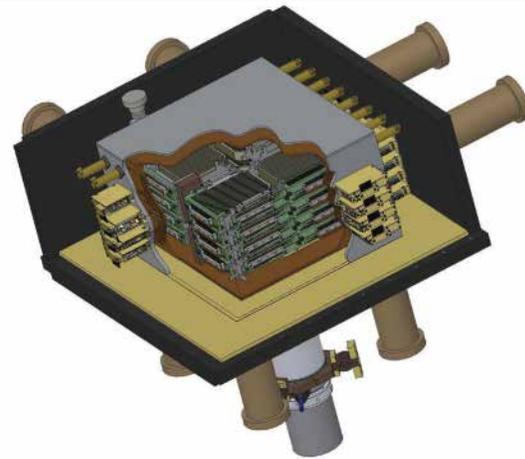
PI: K. France, U Colorado



Do extreme ultraviolet stellar flares zap atmospheres of exoplanets in the habitable zone?

COSI

PI: J. Tomsick/UC Berkeley

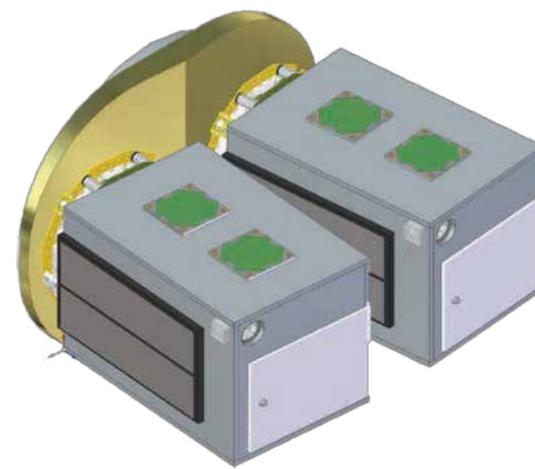


MeV gamma-rays trace Milky Way's supernova activity, positron production; polarization in gamma-ray bursts

Missions of Opportunity

Dorado

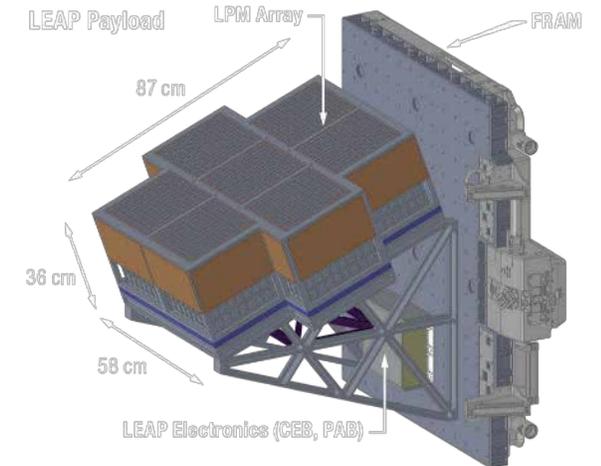
PI: B Cenko/GSFC



Two 12U CubeSats watch for UV light when neutron stars merge

LEAP (on ISS)

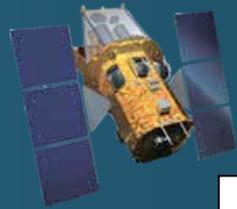
PI: M. McConnell/ U New Hampshire



Polarization of gamma-ray bursts sheds light on jet structure

March 16, 2020: <https://www.nasa.gov/press-release/nasa-selects-proposals-to-study-volatile-stars-galaxies-cosmic-collisions>

Astrophysics Explorers Program



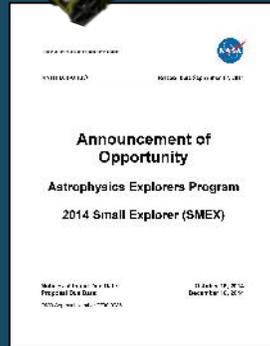
Swift



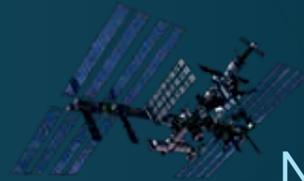
MIDEX
2011



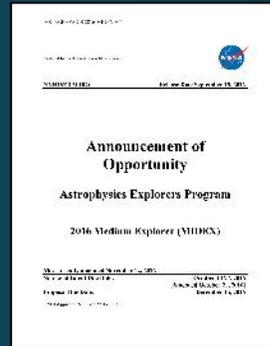
NuSTAR



SMEX
2014



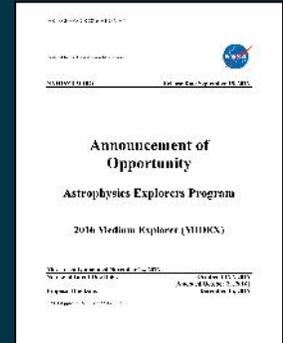
NICER



MIDEX
2016



TESS



MIDEX
2021

Small and
Mid-Size
Missions



TESS



IXPE



SPHEREx

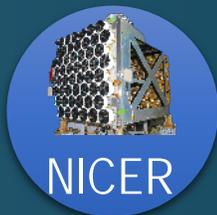
ESCAPE
COSI

Directed
2013



Euclid

Missions of
Opportunity



NICER



GUSTO



ARIEL

Dorado
LEAP

Directed
2017



XRISM

Explorers Policy Update

NASA establishes partnerships with international space agencies to advance its strategic objectives in science

PI proposed partnerships have not been an effective manner of establishing NASA contributions to partner-led missions

- These are “Partner Mission of Opportunity” (PMO) proposals
- Over the past 10 years, we received 17 PMO proposals, selected only 3 for Phase A, and downselected only 1 for flight (ARIEL)
- Of those 3, all could have been initiated strategically instead of PI-proposed
- Of the other 14, most could have been declined without receiving a proposal
- We have concluded that the PMO process is not a successful or efficient process for establishing partnerships

SMD will no longer solicit PMO proposals

- SMD will still allow PI-led Explorers missions to be proposed that include a partner contribution, generally limited to be $<1/3$ of the mission per the AO

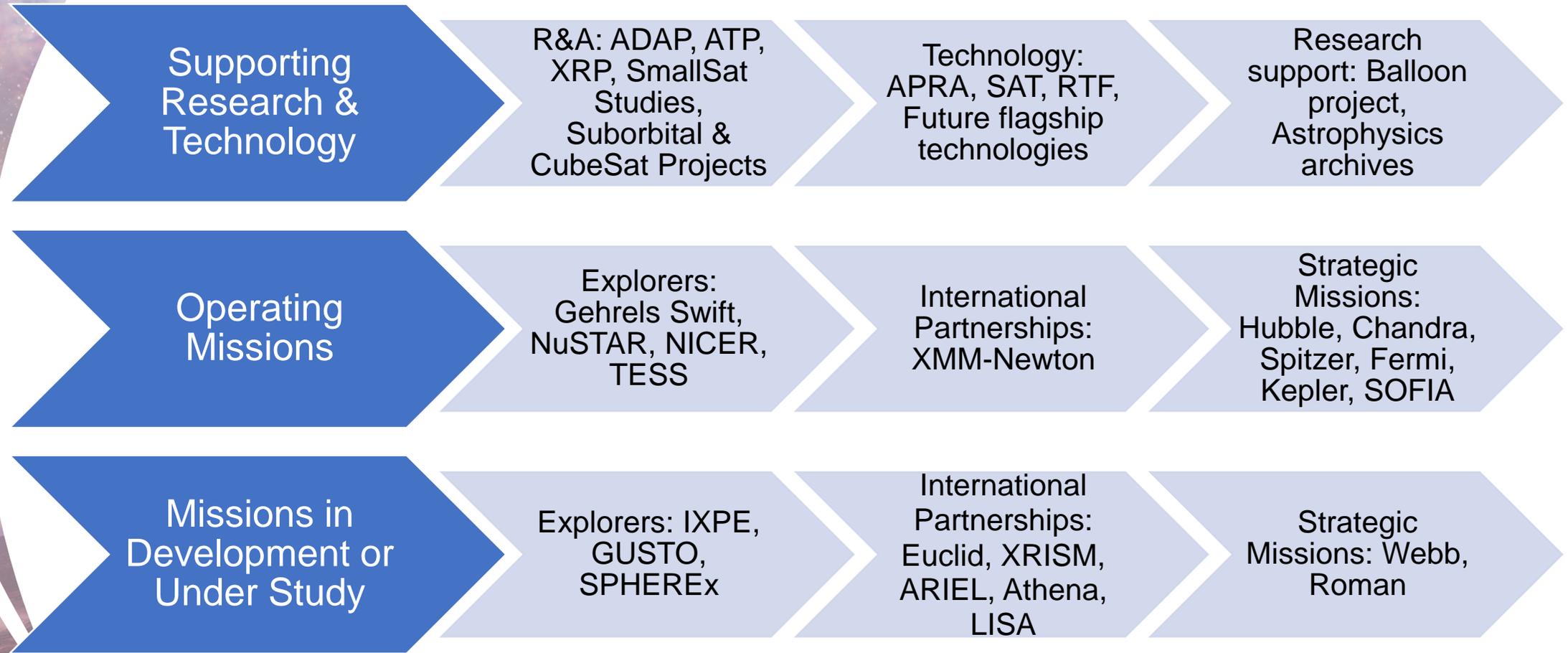
SMD will continue to seek community input on potential partnerships



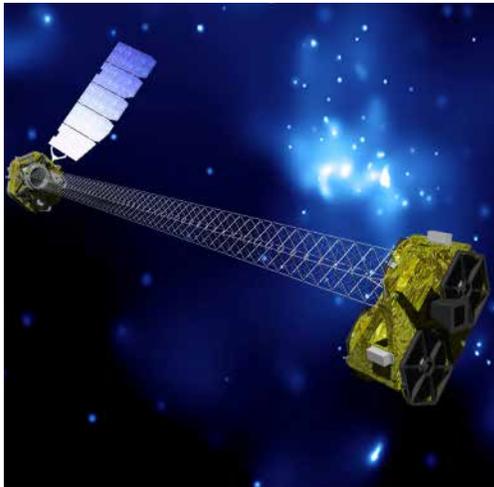
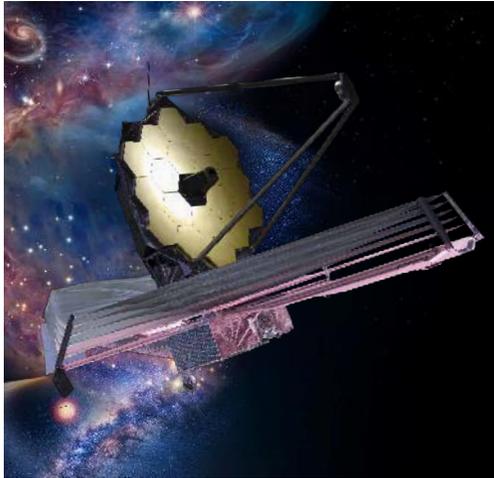
NASA Astrophysics Planning for the Future



NASA Astrophysics Program Summary



FY20 Appropriation



FY20 appropriation for NASA Astrophysics (including Webb Telescope) is \$1.73B; up by \$233M from FY19 appropriation and by \$532M from FY20 President's Budget Request

Fully funds Webb for replan to March 2021 launch date

Fully funds Roman (WFIRST), including the coronagraph technology demonstration instrument, through KDP-C and into Phase C

Specifies funding levels for Hubble, SOFIA, and the Astrophysics Research Program

Provides adequate funding to continue with the rest of the planned Astrophysics programs and projects including:

Operating missions with GO programs as planned following the Senior Review

Development of Explorers missions (IXPE, GUSTO, SPHEREx) and international contributions (Euclid, XRISM, ARIEL, Athena, LISA)

Initiation of Phase A studies for selected SMEX and MO proposals from the 2019 Announcement of Opportunity

Continued technology development for the future



Quick Summary
Community support: 20%
Operating missions: 12%
Building missions: 64%
Management: 4%

MANAGEMENT
INCL. STEM ACTIVATION
4%

RESEARCH
(ADAP, APRA, ATP, ETC.)
6%

TECHNOLOGY
(SR&T, ATHENA, LISA, ETC.)
5%

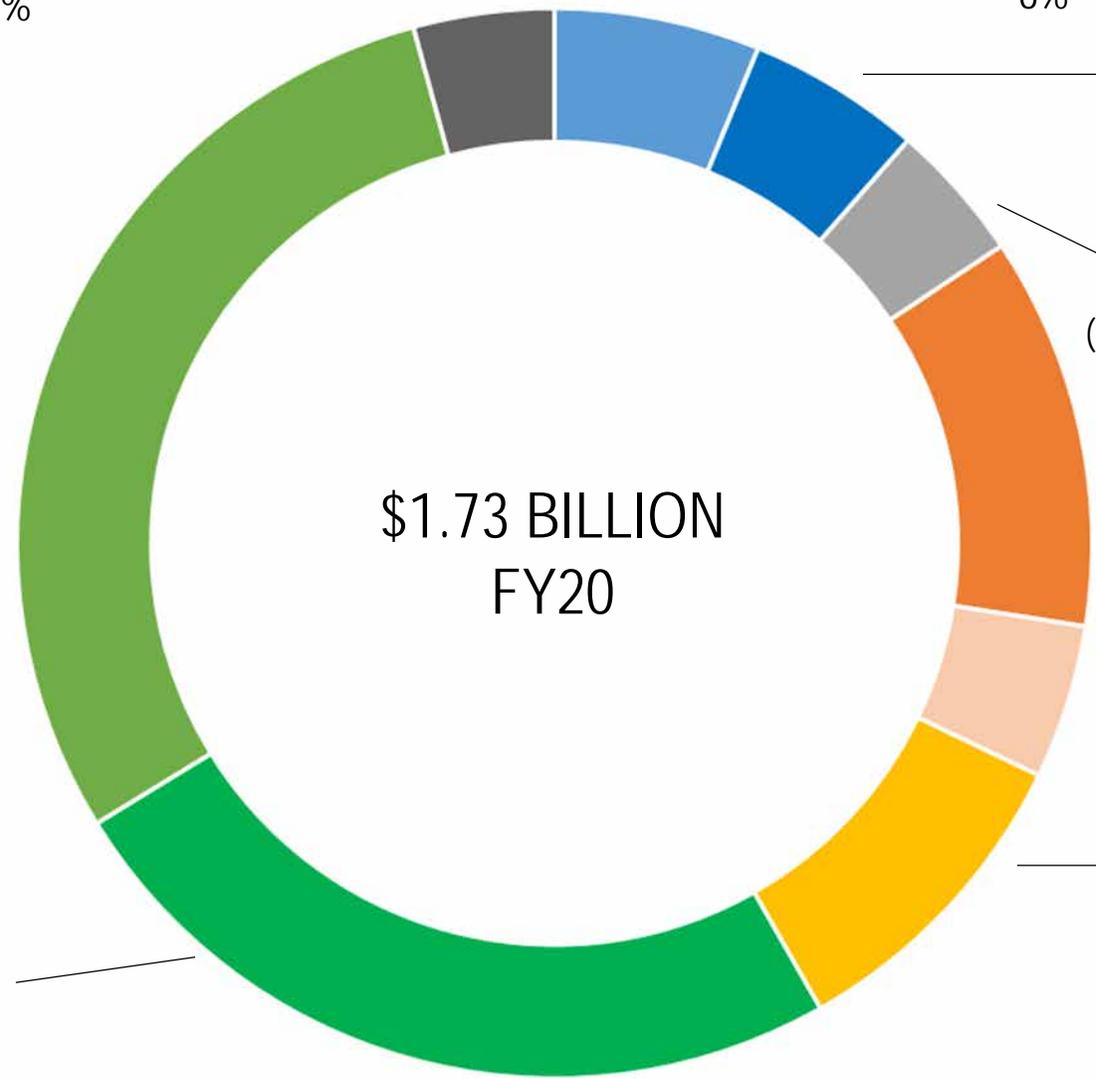
INFRASTRUCTURE
(BALLOON PROGRAM, ARCHIVES, ETC.)
4%

OP. MISSIONS
(INCL. GO PROGRAMS)
17%

EXPLORERS
DEVELOPMENT
10%

ROMAN
DEVELOPMENT
29%

WEBB
DEVELOPMENT
25%



\$1.73 BILLION
FY20

FY21 Budget Agency Highlights

- One of the strongest budgets in NASA's history, investing more than \$25 billion dollars for America's future in space; represents an increase of about 12% over last year's request
- Keeps the agency on track to land the first woman and the next man on the Moon by 2024 and enables development of more than 15 science missions (including lunar, Mars, and Heliophysics) that inform Artemis work
- Provides valuable precursor experience for human exploration of Mars with bold new missions such as Mars Sample Return and Ice Mapper
- Implements a balanced and integrated science program with over 40 missions in formulation and development in FY 2021, including over 25 small missions
- Advances compelling science with priorities identified by the National Academies' decadal surveys including the James Webb Space Telescope, Europa Clipper, IMAP, and the first Earth Science Designated Observables mission
- Executes innovative partnerships with commercial and international partners; including through our Commercial Lunar Payload Services initiative, our industry partners will begin in 2021 to deliver science and tech payloads to virtually anywhere on the Moon, including the poles and far side

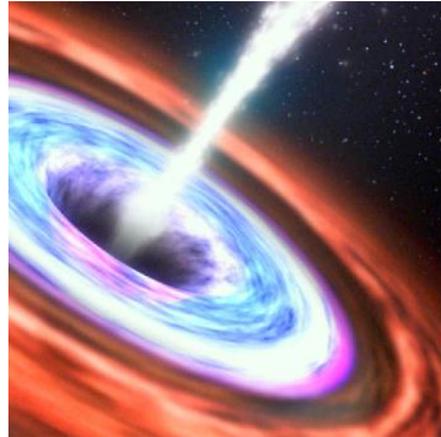
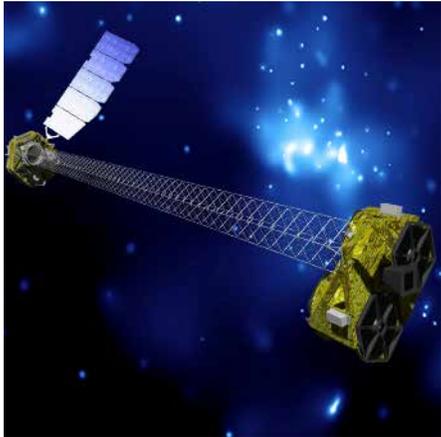
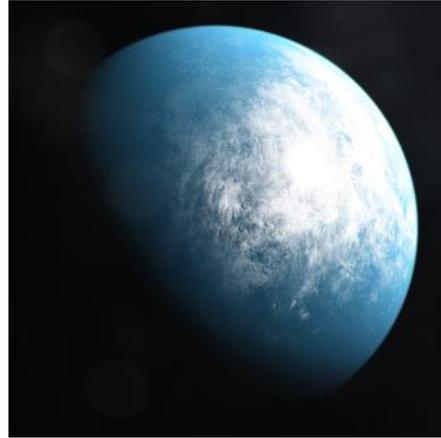
Cost Performance of Recently Launched Missions

NASA Science is providing reliable cost estimates for its missions, contributing to program stability

	KDP-C <u>Baseline</u>	Actual/ <u>Estimated</u>	Actual vs. <u>Original</u>
NuSTAR	109.9	116.0	6%
Landsat 8	583.4	502.8	-14%
IRIS	140.7	143.0	2%
LADEE	168.2	188.2	12%
MAVEN	567.2	472.0	-17%
GPM	555.2	484.3	-13%
OCO-2	249.0	320.3	29%
SMAP	485.7	454.3	-6%
MMS	857.3	875.3	2%
Astro-H	44.9	71.2	59%
OSIRIS-REx	778.6	620.8	-20%
CYGNSS	151.1	127.1	-16%
SAGE-III	64.6	88.2	37%
TSIS-1	49.8	19.8	-60%
TESS	323.2	273.4	-15%
InSight	541.8	635.8	17%
GRACE-FO	264.0	238.1	-10%
Parker	1055.7	955.7	-9%
ICESat 2	558.8	713.2	28%
GED1	91.2	85.5	-6%
OCO-3	62.5	62.2	-1%
<u>ICON</u>	<u>196.0</u>	<u>205.4</u>	<u>5%</u>
Total	7898.7	7652.8	<u>-3%</u>

Science missions launched since the requirement for a 70% JCL have underrun Phase C/D budget commitments by a net 3%

Astrophysics FY21 Budget Request



Supports Webb launch in 2021

Maintains decadal cadence of four AOs per decade for Astrophysics Explorers and Missions of Opportunity

Maintains healthy research program including CubeSats, suborbital missions, technology development, data analysis, theoretical and computational investigations, and laboratory astrophysics

Initiates new class of Astrophysics Pioneers: SmallSats and major balloon missions with reduced management overhead compared to traditional Astrophysics Explorers

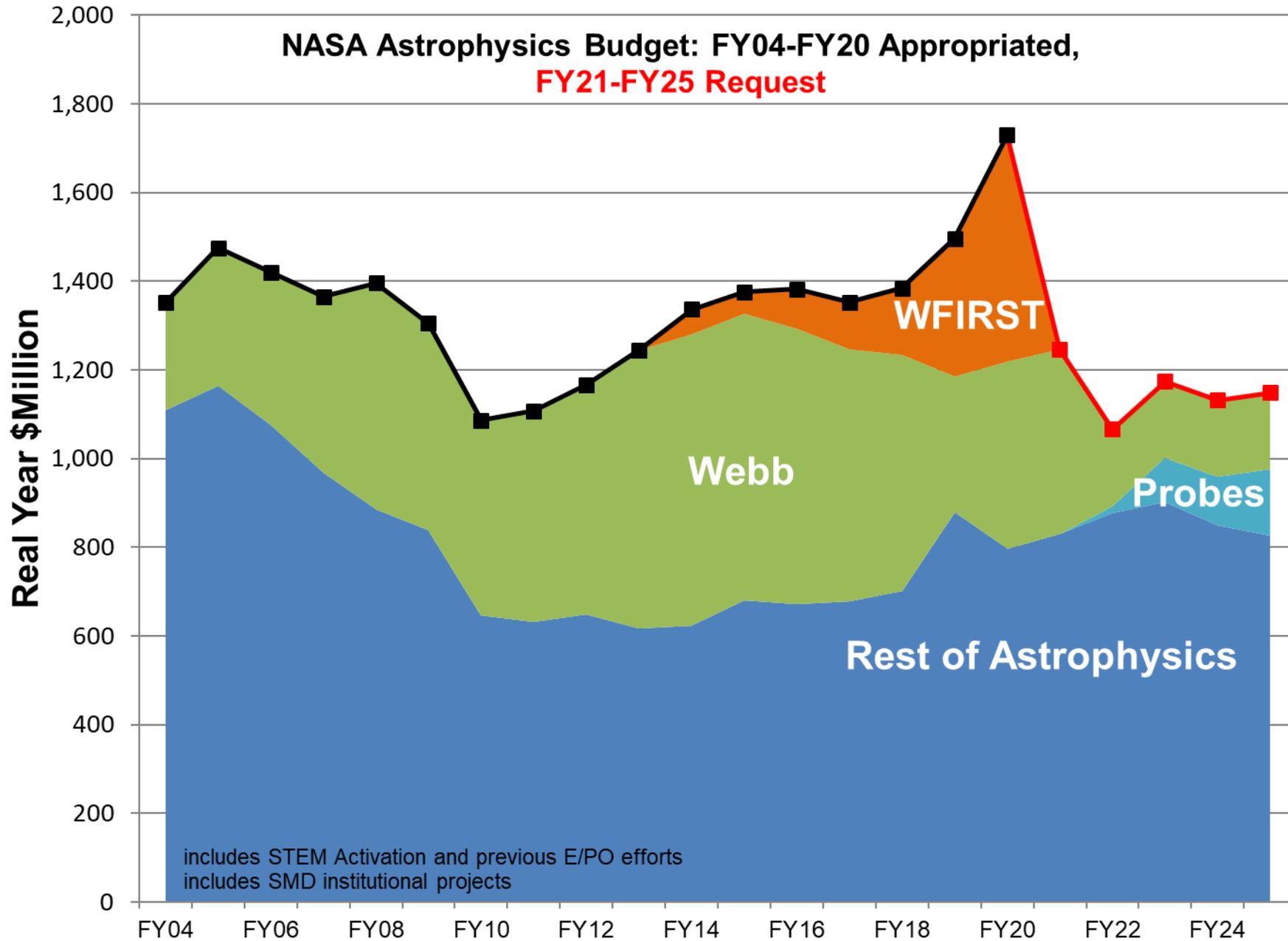
Extends operating missions beyond FY20 with GO programs following 2019 Senior Review

Supports formulation of a probe mission as early as 2022

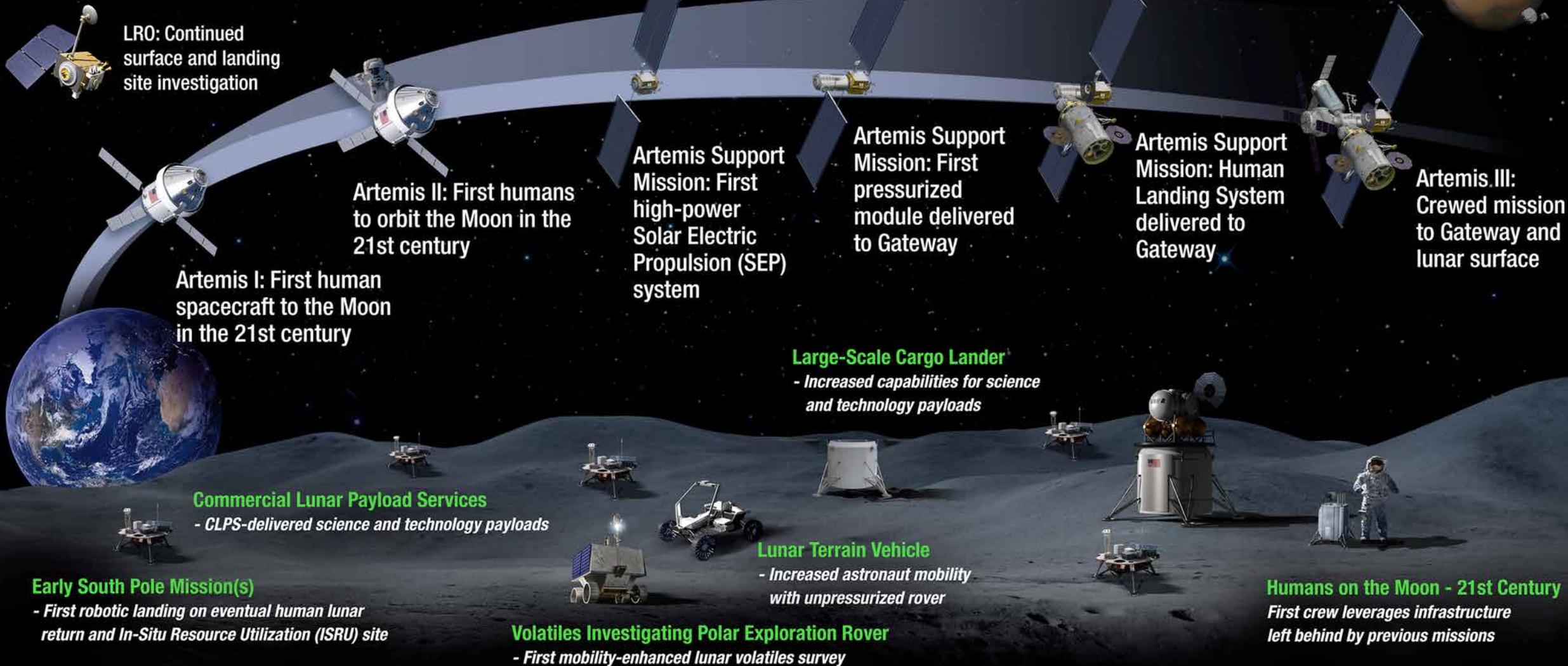
Supports mission concept studies and technology investments to implement Astrophysics Decadal Survey priorities starting in 2022

Terminates SOFIA due to high operating costs and lower science productivity to date

Given its significant cost and competing priorities within NASA, provides no funding for Roman Space Telescope



Humans Return by 2024



LUNAR SOUTH POLE TARGET SITE

2020

2024

Astrophysics and Artemis



All science opportunities enabled by Project Artemis will include astrophysics

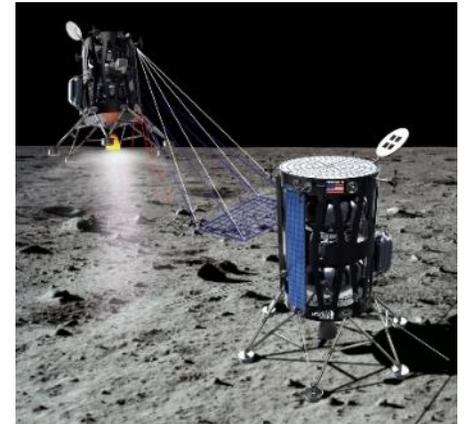
Commercial Lunar Payload Services (CLPS)

- All payload calls include astrophysics; two astrophysics payloads selected
 - Internal NASA call: Low-frequency Radio Observations from the Near Side Lunar Surface instrument (PI: Robert MacDowall, GSFC); manifest through CLPS Task Order 2 on Intuitive Machines Lander for NET October 2021
 - ROSES call: Next Generation Lunar Retroreflectors (PI: Douglas Currie, University of Maryland); to be manifest through CLPS Task Order 19D for ~2022

Astrophysics Explorers 2019 Missions of Opportunity

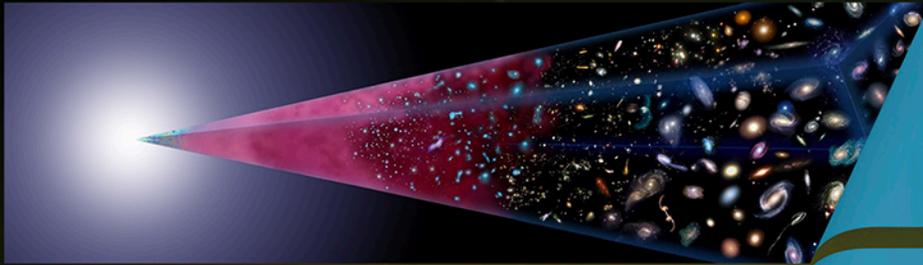
- 2019 AO included opportunities enabled by Project Artemis.
- Future calls will solicit proposals that leverage Artemis capabilities, such as Gateway as a platform and cis-lunar communications infrastructure, to conduct compelling astrophysics investigations.

Most important criterion for all proposals that leverage Artemis remains the astrophysics science merit.



Intuitive Machines Lander

Why Astrophysics?



How did our universe begin and evolve?

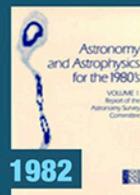


How did galaxies, stars, and planets come to be?



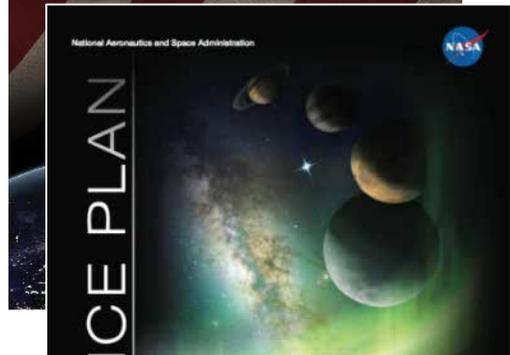
Are we alone?

Enduring National Strategic Drivers

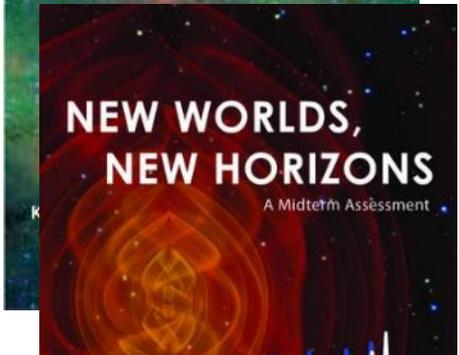
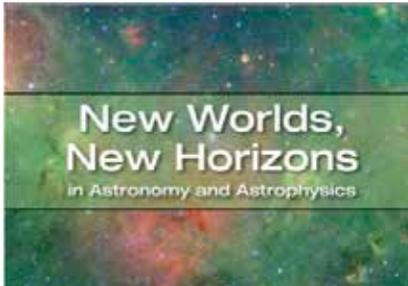
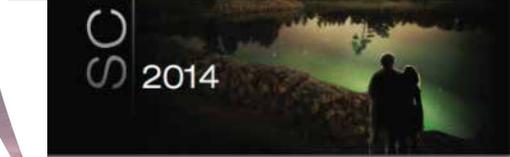


Astrophysics is humankind's scientific endeavor to understand the universe and our place in it.

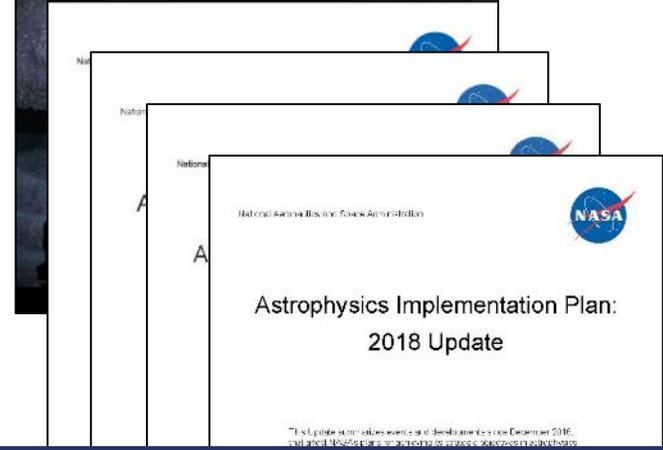
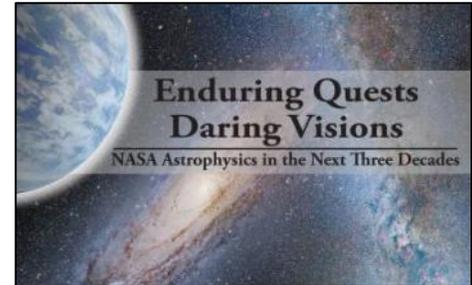
Astrophysics Strategic Planning



To be updated in 2020
(per GPRAMA)

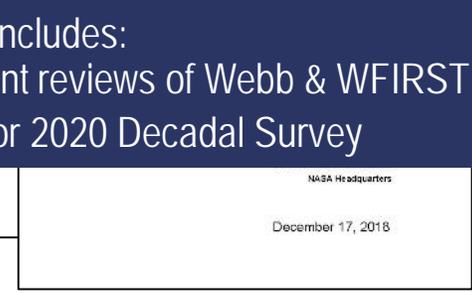


Astro2020 Decadal Survey
underway



2018 update includes:

- Independent reviews of Webb & WFIRST
- Planning for 2020 Decadal Survey



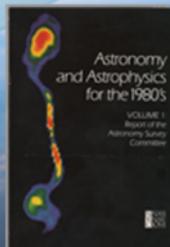
<https://science.nasa.gov/astrophysics/documents>

Astrophysics

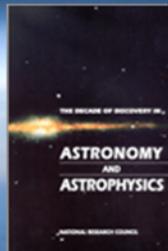
Decadal Survey Missions



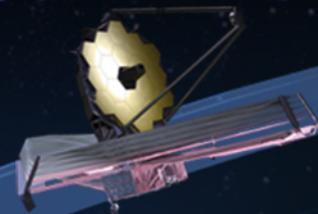
1972
Decadal
Survey
Hubble



1982
Decadal
Survey
Chandra



1991
Decadal
Survey
Spitzer



2001
Decadal
Survey
JWST



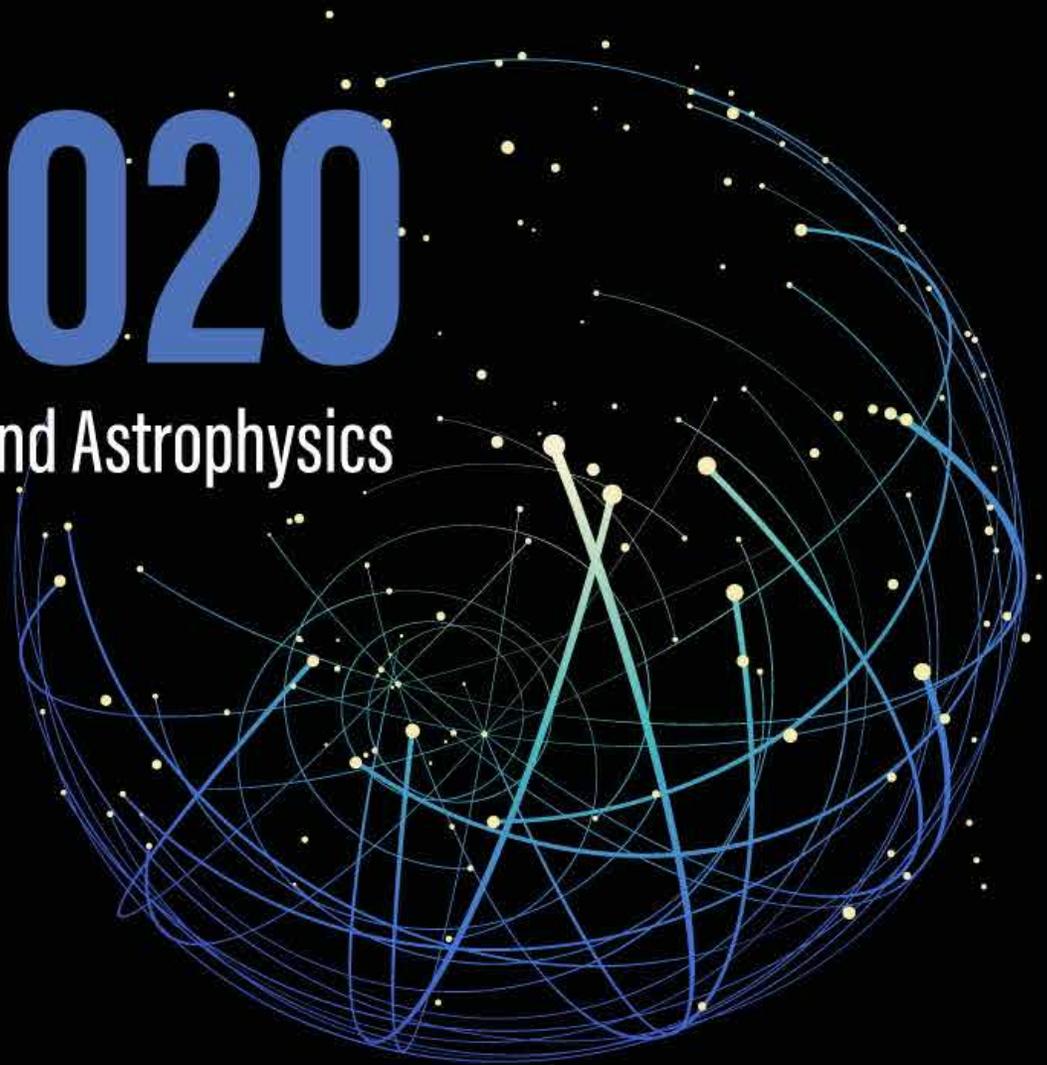
2010
Decadal
Survey
WFIRST

Astro 2020

Decadal Survey on Astronomy and Astrophysics

*The National
Academies of*

SCIENCES
ENGINEERING
MEDICINE



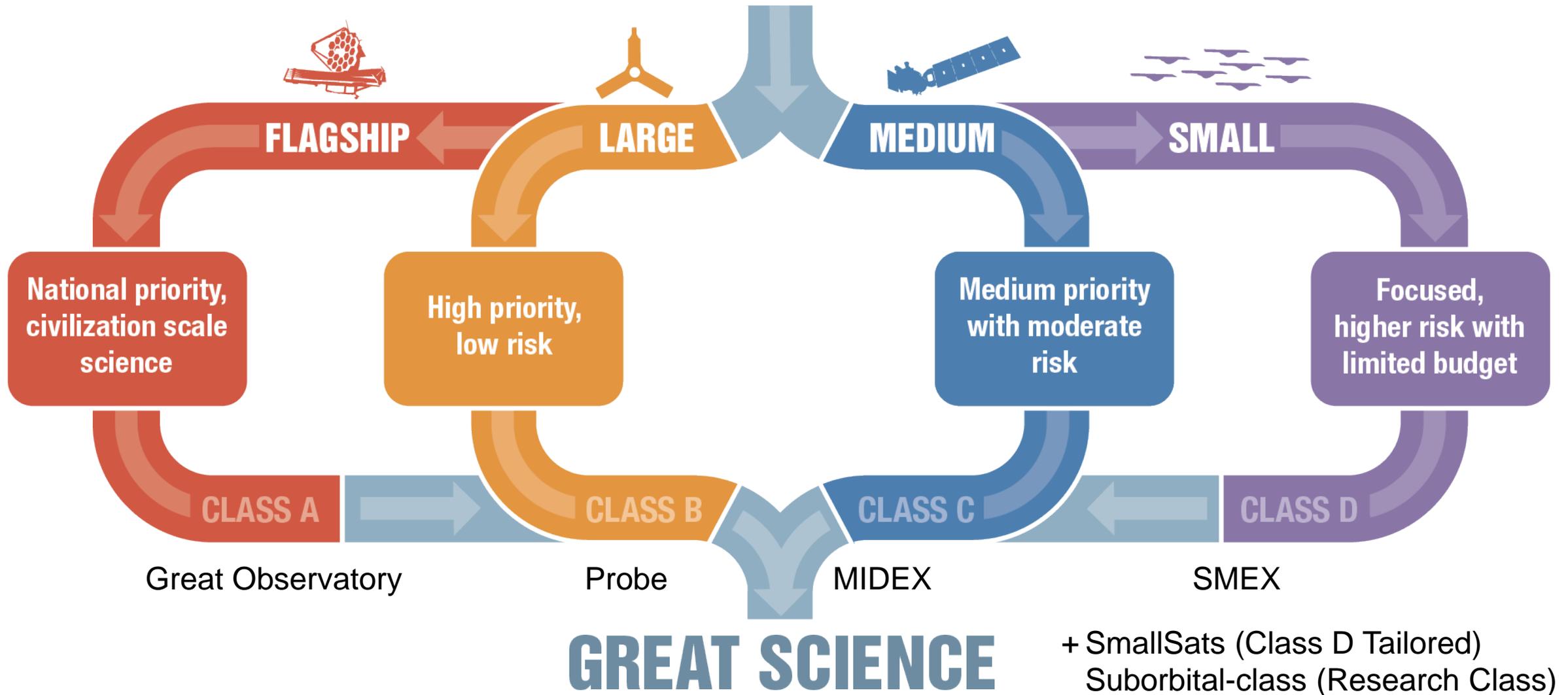
Decadal Survey Goal

NASA's highest aspiration for the 2020 Decadal Survey is that it be ambitious

- The important science questions require new and ambitious capabilities
- Ambitious missions prioritized by previous Decadal Surveys have always led to paradigm shifting discoveries about the universe



BALANCED MISSION PORTFOLIO



Medium Mission Concepts (Probes)

Probes are strategic missions that have had a strong impact on astrophysics, either through a focused investigation or as a broadly-capable observatory



NASA funded probe studies are available at <https://science.nasa.gov/astrophysics/2020-decadal-survey-planning>

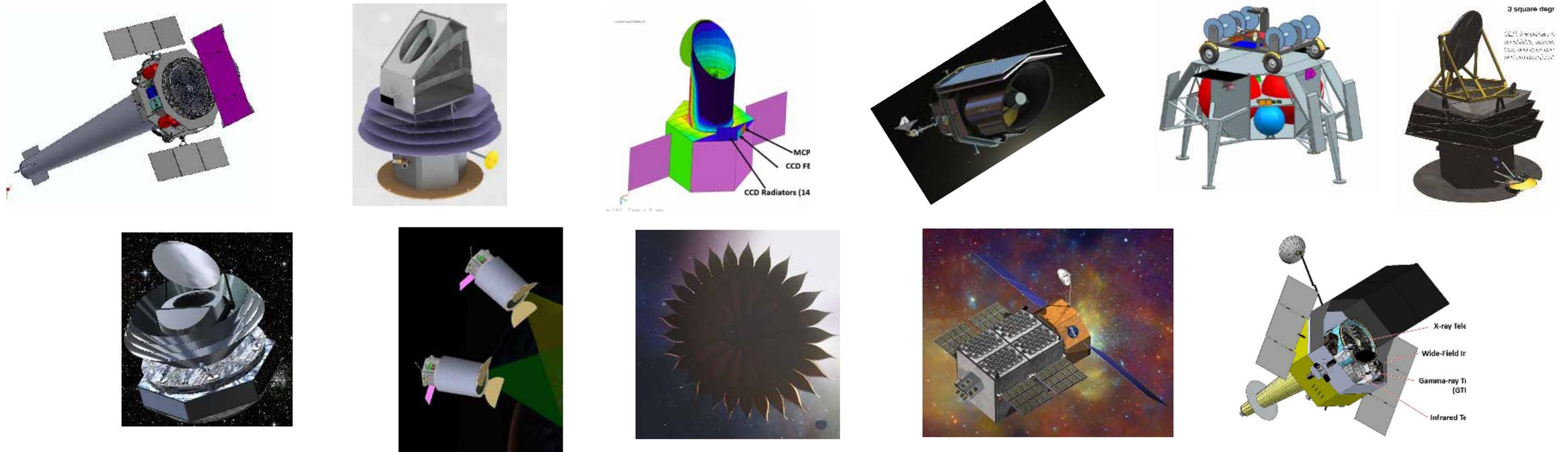
NASA's independent assessment of probe studies by the Probes Cost Assessment Team (PCAT) is available at <https://science.nasa.gov/astrophysics/2020-decadal-survey-planning>

Options for 2020 Decadal Survey

- Do not recommend a medium mission in Astro2020
- Recommend specific probe(s) as medium-size strategic missions
- Recommend several specific science concepts for an AO (similar to New Frontiers)
- Recommend an unconstrained AO (i.e., Super-Explorer)

Probe (Medium Mission) Concepts

Probes are strategic missions that have had a strong impact on astrophysics, either through a focused investigation or as a broadly-capable observatory



NASA funded probe studies are available at <https://science.nasa.gov/astrophysics/2020-decadal-survey-planning>

NASA's independent assessment of probe studies by the Probes Cost Assessment Team (PCAT) is available at <https://science.nasa.gov/astrophysics/2020-decadal-survey-planning>

Why Flagships

Flagships enable paradigm shifting science

Flagships drive US capabilities and contribute to US leadership

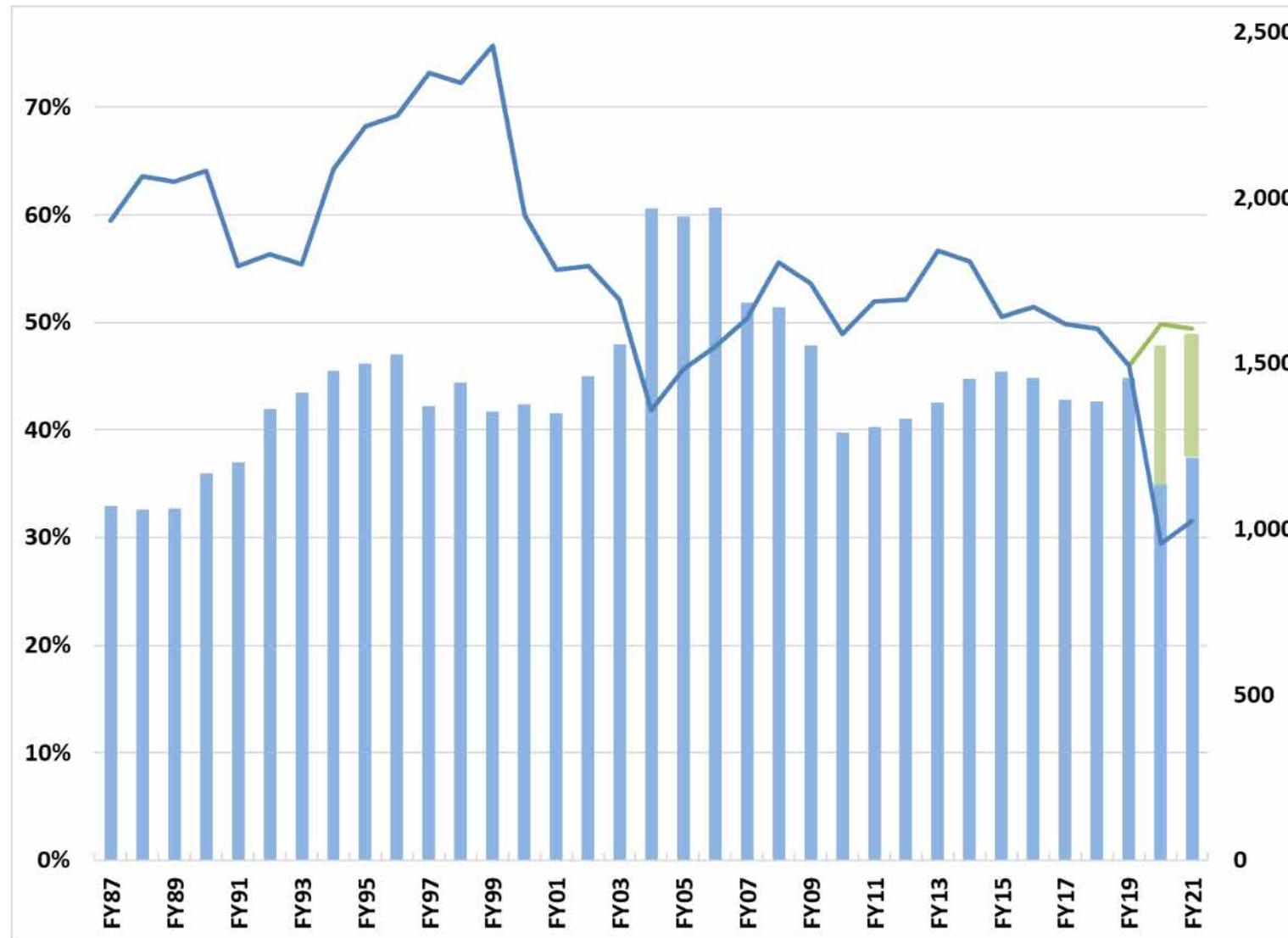
Flagships create stakeholder support that drives the NASA budget



“NASA should continue to plan for large strategic missions as a primary component for all science disciplines as part of a balanced program.”

– Powering Science: NASA's Large Strategic Science Missions (NASEM, 2017)

Flagship Fraction of Astrophysics Budget

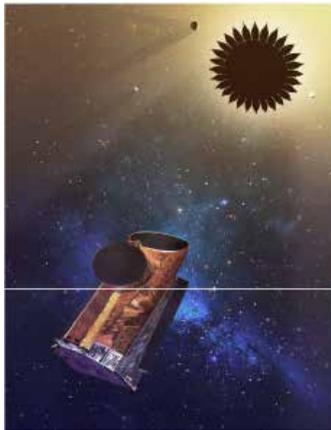


All dollars inflated to FY18\$.
Development only, no ops.

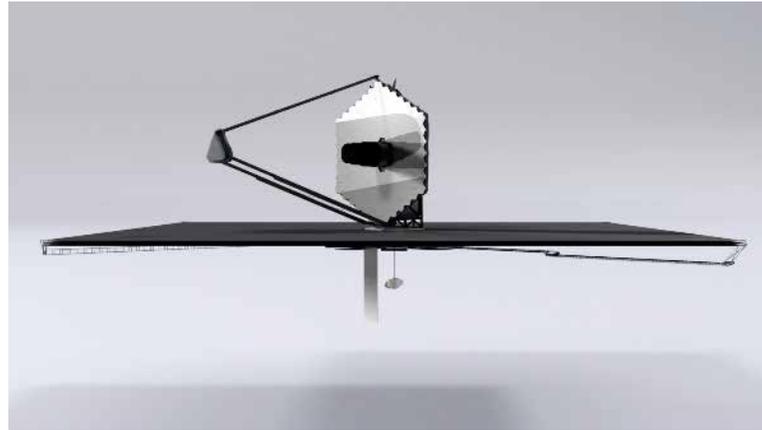
- Large mission fraction (left scale)
- █ Inflation adjusted Astrophysics budget (right scale)
- Current planning budget (without Roman beyond FY19)
- What if Roman is funded as needed on top of FY20 President's Budget Request?

Large Mission Concepts

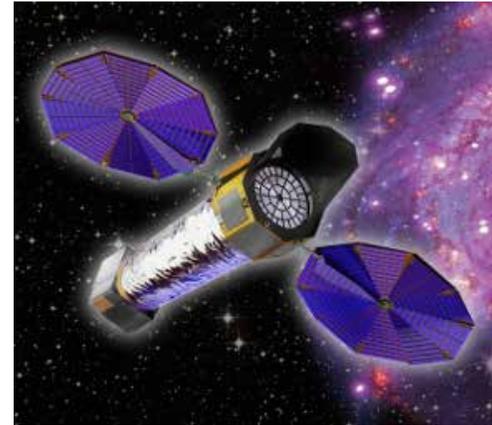
“NASA should ensure that robust mission studies that allow for trade-offs (including science, risk, cost, performance, and schedule) on potential large strategic missions are conducted prior to the start of a decadal survey. These trade-offs should inform, but not limit, what the decadal surveys can address.” – Powering Science: NASA's Large Strategic Science Missions (NASEM, 2017)



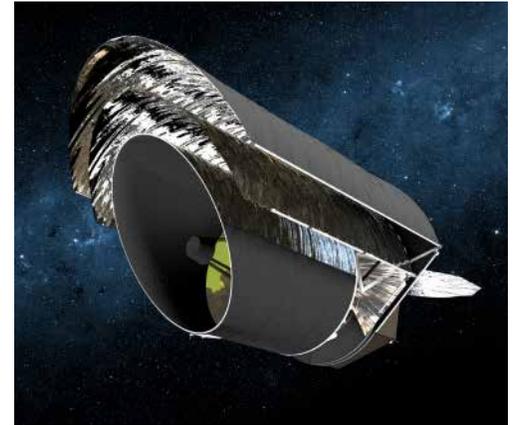
HabEx



LUVOIR



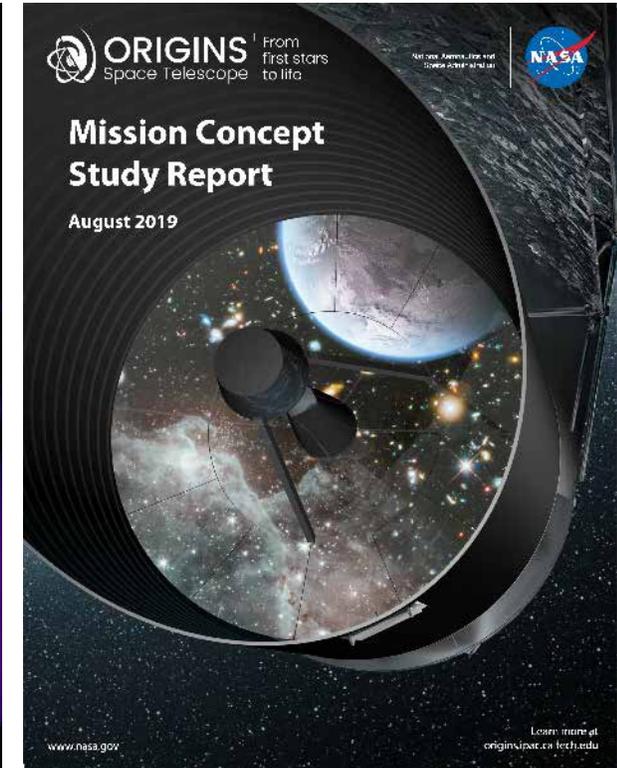
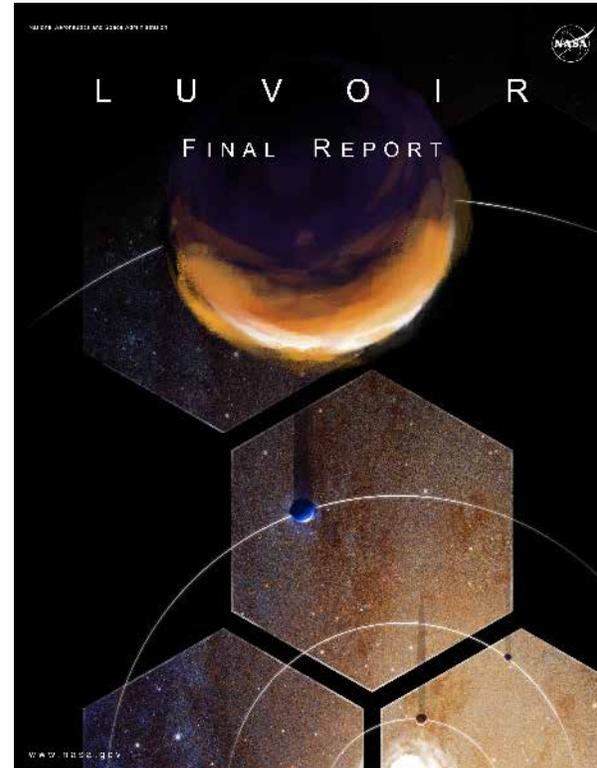
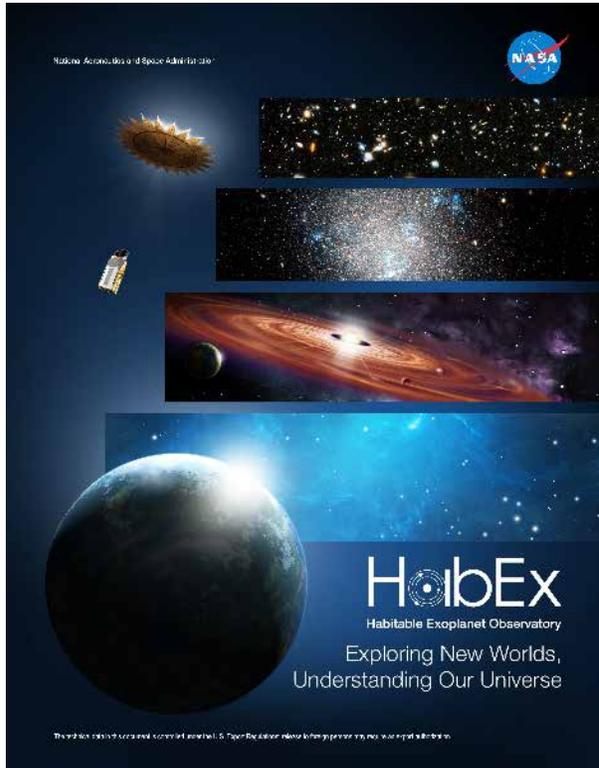
Lynx



Origins

Links to the concept study reports are posted at <https://science.nasa.gov/astrophysics/2020-decadal-survey-planning> and at <https://www.greatobservatories.org/>

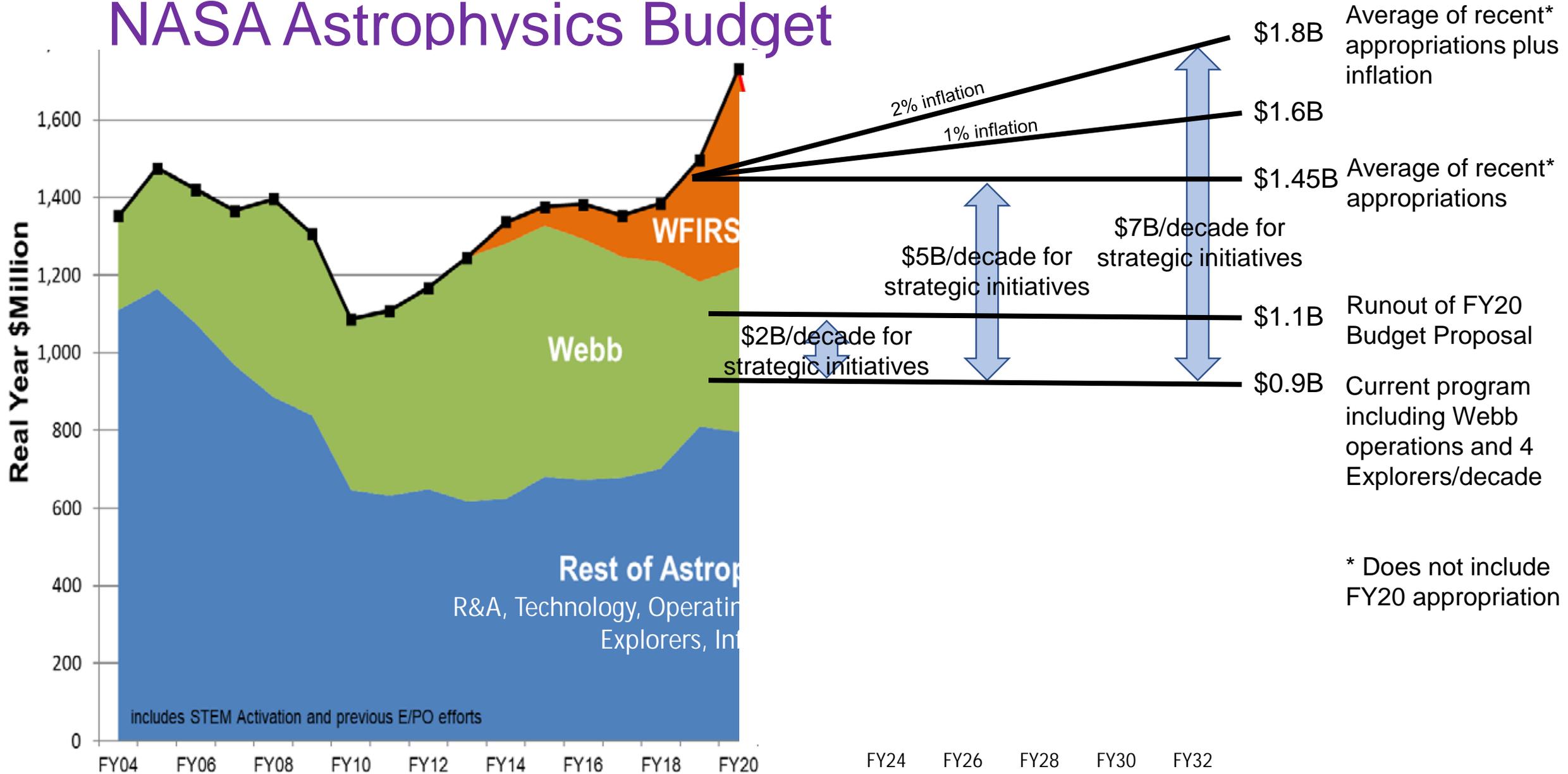
Large Mission Concepts



NASA's independent assessment by the Large Mission Concept Independent Assessment Team (LCIT) is available at <https://science.nasa.gov/astrophysics/2020-decadal-survey-planning>

Links to the concept study reports are posted at <https://science.nasa.gov/astrophysics/2020-decadal-survey-planning> and at <https://www.greatobservatories.org/>

NASA Astrophysics Budget



Decadal Survey Goal

NASA's highest aspiration for the 2020 Decadal Survey is that it be ambitious

- The important science questions require new and ambitious capabilities
- Ambitious missions prioritized by previous Decadal Surveys have always led to paradigm shifting discoveries about the universe

If you plan to a diminishing budget, you get a diminishing program

- Great visions inspire great budgets

Carpe Posterum





The Future

This is an exciting time for Astrophysics – we are pursuing the answers to the biggest questions

- How did the universe begin and evolve?
- How did galaxies, stars, and planets come to be?
- Are we alone?

Astrophysics is multiwavelength and multimessenger

- NASA has 10 operating astrophysics missions*
- NASA is developing 10 astrophysics missions* and studying 4 for downselect

The community will select NASA's future observatories through the 2020 Decadal Survey and through peer review of competed missions (like Explorers)

NASA is ready to realize the community's priorities

* includes partner-led missions



Slides posted at
<http://science.nasa.gov/astrophysics/documents>





BACKUP



- Formulation
- Implementation
- Primary Ops
- Extended Ops

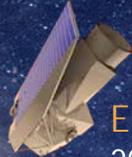
+ SMEX/MO (2025),
MIDEX/MO (2028), etc.



Spitzer
8/25/2003
1/30/2020



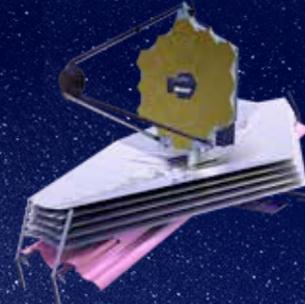
Roman
2025/2026



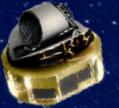
Euclid (ESA)
2022



SXG (RSA)
7/13/2019



Webb
2021



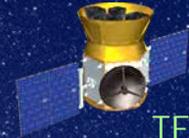
Ariel (ESA)
2028



Chandra
7/23/1999



XMM-Newton (ESA)
12/10/1999



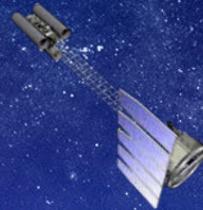
TESS
4/18/2018



NuSTAR
6/13/2012



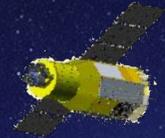
Fermi
6/11/2008



IXPE
2021



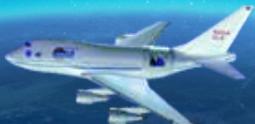
SPHEREx
2023



XRISM (JAXA)
2022



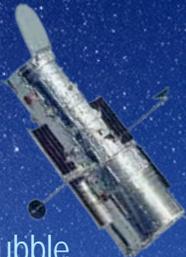
Swift
11/20/2004



SOFIA
Full Ops 5/2014



GUSTO
2021



Hubble
4/24/1990



ISS-NICER
6/3/2017

+ Athena (early 2030s),
LISA (early 2030s)

Science Budget Request Summary (\$M)

	Actual	Request	Enacted	Request	Out-years			
	FY 19	FY 20	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25
Science	6,886.6	6,393.7	7,138.9	6,306.5	6,553.5	6,575.7	6,705.2	6,766.9
Earth Science	1,931.0	1,779.8	1,971.8	1,768.1	1,878.2	1,846.1	1,834.5	1,984.6
Earth Science Research	454.1	447.9		447.3	471.9	494.1	528.5	530.3
Earth Systematic Missions	932.7	719.2		608.3	706.1	695.6	640.7	797.3
Earth System Science Pathfinder	223.8	275.4		338.9	301.2	251.6	241.8	234.4
Earth Science Data Systems	202.0	214.4		245.4	259.9	263.2	278.7	277.7
Earth Science Technology	63.4	69.6		74.2	82.8	84.6	86.4	86.4
Applied Sciences	55.1	53.3		53.9	56.3	57.0	58.5	58.5
Planetary Science	2,746.7	2,712.1	2,713.4	2,659.6	2,800.9	2,714.9	2,904.8	2,830.7
Planetary Science Research	276.6	266.2		305.4	288.6	285.1	295.2	286.7
Planetary Defense	150.0	150.0	160.0	150.0	147.2	97.6	98.0	98.0
Lunar Discovery and Exploration	188.0	300.0	300.0	451.5	517.3	491.3	458.3	458.3
Discovery	409.5	502.7		484.3	424.4	434.8	570.1	505.8
New Frontiers	93.0	190.4		179.0	314.3	332.8	326.9	285.0
Mars Exploration	712.7	546.5	570.0	528.5	588.4	671.2	798.7	855.3
Outer Planets and Ocean Worlds	793.6	608.4		414.4	370.7	239.4	192.3	171.7
Radioisotope Power	123.3	147.9	147.9	146.3	150.1	162.8	165.4	169.8
Astrophysics	1,191.1	844.8	1,306.2	831.0	891.2	1,000.9	959.7	975.5
Astrophysics Research	222.8	250.7		269.7	279.1	327.2	314.9	331.1
Cosmic Origins	222.8	185.3		124.0	123.2	120.0	122.4	122.4
Physics of the Cosmos	151.2	148.4		143.9	160.8	155.3	169.8	154.1
Exoplanet Exploration	367.9	46.4		47.2	50.4	47.6	51.6	52.2
Astrophysics Explorer	226.5	214.1		246.2	277.7	350.8	301.0	315.6
James Webb Space Telescope	305.1	352.6	423.0	414.7	175.4	172.0	172.0	172.0
Heliophysics	712.7	704.5	724.5	633.1	807.8	841.8	834.1	804.1
Heliophysics Research	248.9	237.0		230.5	218.7	225.2	224.0	224.5
Living with a Star	135.3	107.6		127.9	134.5	246.4	225.5	233.3
Solar Terrestrial Probes	180.5	177.9	183.2	126.3	262.2	202.6	195.6	115.5
Heliophysics Explorer Program	147.9	182.0	182.0	148.4	192.4	167.6	189.0	230.8

Astrophysics Program Content

	Actual	Request	Enacted	Request	Out-years			
	FY 19	FY 20	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25
Astrophysics	1,191.1	844.8	1,306.2	831.0	891.2	1,000.9	959.7	975.5
<u>Astrophysics Research</u>	<u>222.8</u>	<u>250.7</u>	<u>250.7</u>	<u>269.7</u>	<u>279.1</u>	<u>327.2</u>	<u>314.9</u>	<u>331.1</u>
Astrophysics Research and Analysis	83.4	86.6		90.2	92.2	94.2	94.2	94.2
Balloon Project	40.2	44.8		44.8	45.8	45.7	46.3	46.3
Science Activation	45.0	45.6	45.6	45.6	45.6	45.6	45.6	45.6
<u>Other Missions and Data Analysis</u>	<u>54.2</u>	<u>73.7</u>		<u>89.1</u>	<u>95.5</u>	<u>141.7</u>	<u>128.8</u>	<u>145.0</u>
Astrophysics Data Curation and Archival	17.9	21.2		24.5	26.3	26.4	28.5	28.7
Astrophysics Data Program	19.1	20.4		21.6	22.6	23.6	23.6	23.6
Astrophysics Senior Review		-				51.2	50.4	49.9
Contract Administration, Audit & QA Svcs	12.7	12.7		17.3	17.3	17.3	17.3	17.3
Astrophysics Directed R&T	4.5	19.4		25.7	29.4	23.3	9.0	25.5
<u>Cosmic Origins</u>	<u>222.8</u>	<u>185.3</u>		<u>124.0</u>	<u>123.2</u>	<u>120.0</u>	<u>122.4</u>	<u>122.4</u>
Hubble Space Telescope	98.3	83.3	90.8	88.3	98.3	98.3	98.3	98.3
SOFIA	85.2	73.0	85.2	12.0				
<u>Other Missions and Data Analysis</u> (development / formulation / technology)	<u>39.3</u>	<u>29.0</u>		<u>23.7</u>	<u>24.9</u>	<u>21.7</u>	<u>24.1</u>	<u>24.1</u>
Cosmic Origins SR&T	24.8	17.1		18.4	18.4	18.4	18.4	18.4
Cosmic Origins Future Missions	0.8	2.2		2.7	4.6	1.6	3.8	3.8
(operating)								
Spitzer	13.2	8.5		1.0				
(research and management)								
Astrophysics Strategic Mission Prog Mgmt	0.4	1.2		1.6	1.9	1.7	1.9	2.0

Astrophysics Program Content

	Actual	Request	Enacted	Request	Out-years			
	FY 19	FY 20	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25
<u>Physics of the Cosmos</u>	<u>151.2</u>	<u>148.4</u>		<u>143.9</u>	<u>160.8</u>	<u>155.3</u>	<u>169.8</u>	<u>154.1</u>
(development / formulation / technology)								
Euclid	17.2	13.7		11.0	8.9	9.9	10.3	9.5
Physics of the Cosmos SR&T	45.7	50.9		45.9	61.2	75.2	87.0	72.1
Physics of the Cosmos Future Missions	0.0	2.0		1.6	4.6	2.0	3.7	3.7
(operating)								
Chandra X-Ray Observatory	61.7	58.4		62.3	62.8	62.8	62.8	62.8
Fermi Gamma-ray Space Telescope	16.5	14.0		13.8	13.9			
XMM	4.5	3.5		3.5	3.5			
(research and management)								
PCOS/COR Technology Office Management	5.6	5.9		5.9	6.0	5.4	6.0	6.0
<u>Exoplanet Exploration</u>	<u>367.9</u>	<u>46.4</u>		<u>47.2</u>	<u>50.4</u>	<u>47.6</u>	<u>51.6</u>	<u>52.2</u>
(development / formulation / technology)								
WFIRST	312.2		510.7					
Exoplanet Exploration SR&T	32.1	29.1		31.5	32.0	31.3	30.5	31.2
Exoplanet Exploration Future Missions	0.7	2.8		1.7	3.5	1.6	5.4	5.4
(operating)								
Keck Operations	6.5	6.7		6.9	7.0	7.2	7.4	7.4
Kepler	8.9	1.3						
(research and management)								
Exoplanet Exploration Technoloy Off Mgmt	7.5	6.5		7.1	7.8	7.4	8.2	8.1

Astrophysics Program Content

	Actual	Request	Enacted	Request	Out-years			
	FY 19	FY 20	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25
<u>Astrophysics Explorer</u>	<u>226.5</u>	<u>214.1</u>		<u>246.2</u>	<u>277.7</u>	<u>350.8</u>	<u>301.0</u>	<u>315.6</u>
(development / formulation / technology)								
SPHEREx	22.2			90.8	109.1	87.7	28.4	13.0
Imaging X-Ray Polarimetry Explorer	57.0	70.2		45.3	7.4	4.5	0.5	
X-Ray Imaging and Spectroscopy Mission	23.2	29.7		25.1	36.3	17.7	15.9	14.4
CASE				11.9	10.2	10.0	6.4	1.0
GUSTO	19.9	11.1		7.8	5.8	1.0		
Astrophysics Explorer Future Missions	2.3	84.8		10.6	58.0	219.2	241.5	278.1
Universe Explorer Prior Hist Projects	70.0							
(operating)								
Transiting Exoplanet Survey Satellite	7.7	5.0		14.7	14.1			
Nuclear Spectroscopic Telescope Array	8.5	7.8		8.6	8.6			
Neil Gehrels Swift Observatory	7.0	5.5		5.8	5.8			
NICER	3.8			4.8	4.4			
(research and management)								
Astrophysics Explorer Program Management	4.9			20.7	18.0	10.7	8.3	9.1
<u>James Webb Space Telescope</u>	<u>305.1</u>	<u>352.6</u>	<u>423.0</u>	<u>414.7</u>	<u>175.4</u>	<u>172.0</u>	<u>172.0</u>	<u>172.0</u>
<u>Astrophysics + Webb Total</u>	<u>1,496.2</u>	<u>1,197.3</u>	<u>1,729.2</u>	<u>1,245.7</u>	<u>1,066.6</u>	<u>1,172.9</u>	<u>1,131.7</u>	<u>1,147.5</u>

SMD Organization Chart

